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WATER RESOURCES APPRAISAL
FOR HYDROELECTRIC LICENSING

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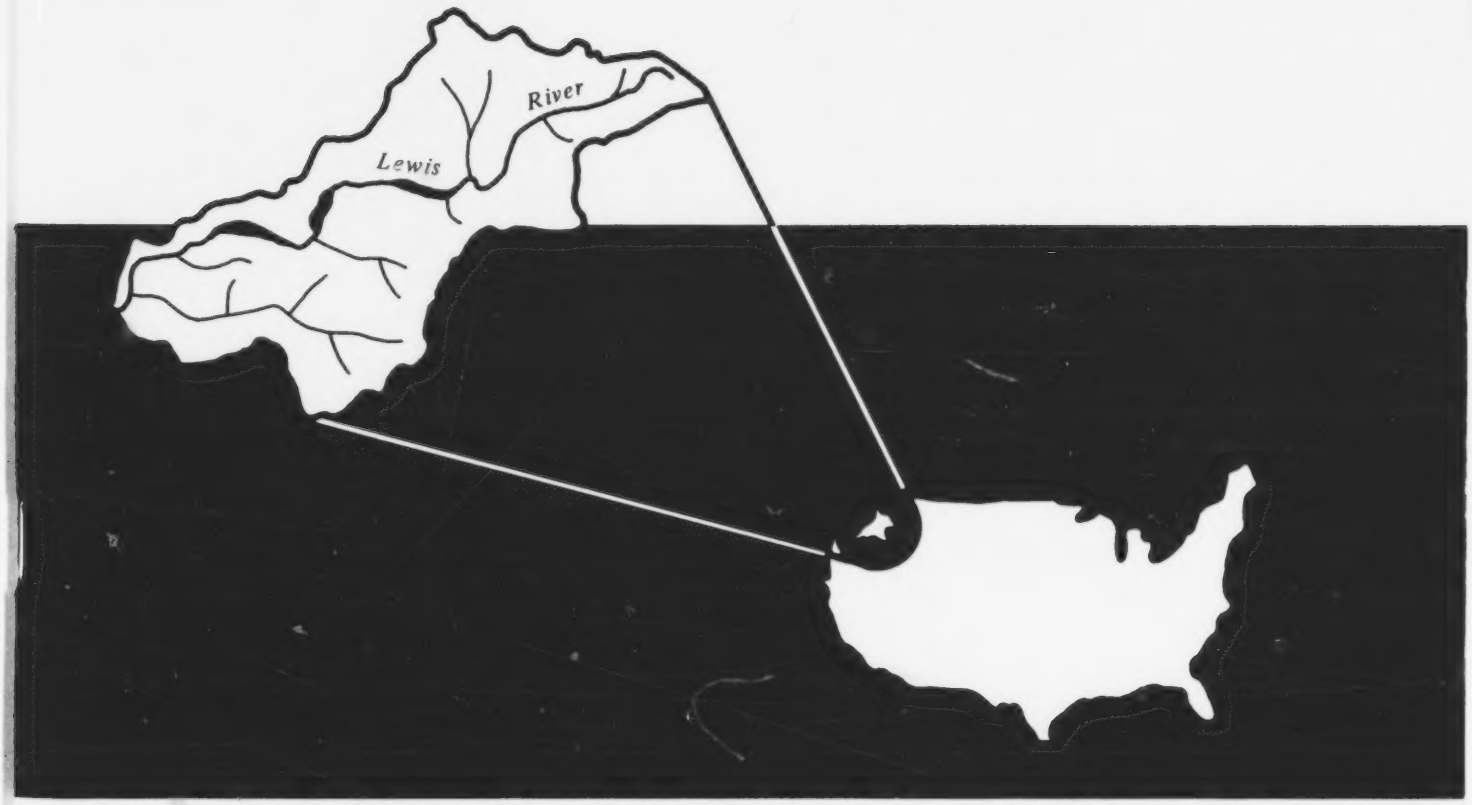

FEDERAL ENERGY REGULATORY COMMISSION

OFFICE OF ELECTRIC POWER REGULATION

JANUARY 1981

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FERC-0067

APPRAISAL REPORT

WATER RESOURCES APPRAISAL
FOR HYDROELECTRIC LICENSING

LEWIS RIVER BASIN

WASHINGTON

FEDERAL ENERGY REGULATORY COMMISSION
OFFICE OF ELECTRIC POWER REGULATION
SAN FRANCISCO REGIONAL OFFICE

JANUARY 1981

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PREFACE

The Federal Power Act, as amended, authorized the Federal Power Commission to undertake investigations of the water resources of any region to be developed; to cooperate with the executive departments and other agencies of Federal and State governments in water resources planning; and to issue licenses to non-Federal interests for the construction, operation, and maintenance of dams, powerhouses, and appurtenances for hydroelectric power development and other purposes. The Act reserves to the United States the right to take over a non-publicly owned project upon expiration of the license after paying the licensee's net investment in the project, not to exceed fair value of property taken, plus severance damages, if any. Projects to be licensed or relicensed must, in the judgment of the Commission, be best adapted to a comprehensive plan for improving waterways for the benefit of interstate commerce, for water power development, and for other beneficial public uses, including recreation.

On October 1, 1977, pursuant to the provisions of the Department of Energy Organization Act (DOE Act), Public Law 95-91, 91 Stat. 565 (August 4, 1977) and Executive Order No. 12009, 42 Fed. Reg. 46267 (September 15, 1977), the Federal Power Commission (FPC) ceased to exist, and its functions and regulatory responsibilities were transferred to the Secretary of Energy and the Federal Energy Regulatory Commission (FERC) which, as an independent commission within the Department of Energy, was activated on October 1, 1977. On December 23, 1977, the Secretary issued an order amending DOE Delegation Order No. 0204-1 further delegating to the FERC the authority, under section 4(a) of the Federal Power Act, to continue its activities as they relate to river basin appraisals.

For the purposes of this report, all references to the "Commission" when used in the context of an action taken prior to October 1, 1977, refer to the FPC; when used otherwise, the reference is to the FERC.

This report on the Lewis River basin, Washington, has been prepared by the staff of the Commission as part of a program of Water Resources Appraisals for Hydroelectric Licensing. Mr. Bernard Smith of the Commission's San Francisco Regional Office was primarily responsible for the conduct of studies and for the preparation of the report.

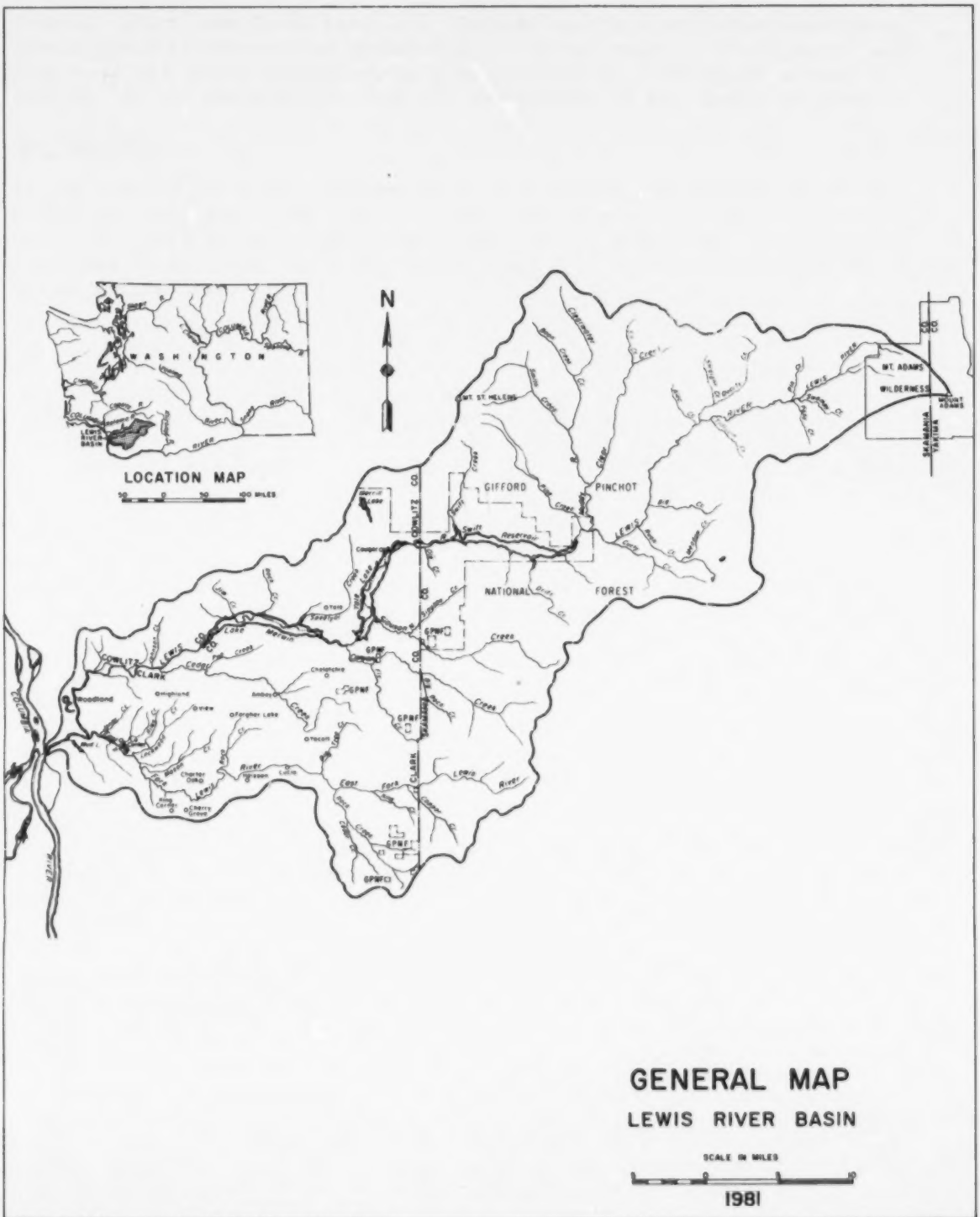
This report is intended primarily to provide information which the Commission and its staff may use or build upon, as appropriate, when considering matters related to hydroelectric project licensing, relicensing, or recommendation for Federal takeover. It has been prepared to correlate and, when possible, to supplement available information and thus enable the staff and the Commission to act expeditiously on matters pertaining to the development of the hydroelectric power potential of the Lewis River basin within the limitations of other desirable water uses and environmental concerns. The report is a staff study which was not prepared for adoption or approval by the Commission and does not necessarily reflect the views of the Commission nor commit or prejudge later Commission action.

Much of the material in the report is based on reconnaissance-type information, but more precise data have been used where available. The basic material used in preparing the report has largely been abstracted from previous reports of

Federal, State, and local entities. Several agencies and individuals have participated in discussions pertaining to the information in the report and have provided useful background data or suggestions. The plans presented, however, do not necessarily carry the endorsement of any agency or group.

Special Note:

At the time of the final preparation of this report, the volcano at Mt. St. Helens was erupting. The impacts of this activity on the Lewis River basin will not likely be fully known and documented for some time. Consequently, there may be information in this report that will require updating at an appropriate future date.



F E R C - Water Resources Appraisal for Hydroelectric Licensing

Figure 1

SUMMARY

The Lewis River, Washington, is a tributary to the Columbia River, joining the latter about 19 miles (31 km) north of Vancouver, Washington. Its watershed of 1,046 square miles (2,709 km^2) occupies most of the area lying between the ridge of the Cascade Range on the east and the Columbia River on the south and west, and the Kalama and Cowlitz River basins on the north. The Lewis River flows south-westerly from its headwaters on Mt. Adams to the lower Columbia River. Its main tributaries are the Muddy River, which drains the southeastern slopes of Mt. St. Helens and mountains farther east, and the East Fork Lewis River, which drains the southern part of the area and joins the Lewis River about 3 miles (5 km) upstream from its confluence with the Columbia River.

The climate of the Lewis River basin is characterized by mild, wet winters and cool, dry summers. The average annual precipitation varies greatly, depending on locale and is directly related to elevation. Average annual precipitation varies from a minimum of 35 inches (89 cm) along the Columbia River to 140 inches (356 cm) atop Mt. St. Helens. The form of this precipitation is generally rain, with snowfall in the higher mountain ranges. Discharges of the Lewis River have been measured by the U.S. Geological Survey near the Merwin Dam since 1923. The drainage area at the gage is 731 square miles (1,893 km^2), and the average annual flow for the 54-year period of record through 1977 was 4,875 cubic feet per second (138 m^3/s). Flow variability in the Lewis River is decreased by the effects of natural storage in snowfields, glaciers, and groundwater reservoirs, and by regulation provided from upstream hydroelectric power reservoirs. Water is low in dissolved solids and chemical constituents and is generally of excellent quality.

Logging and processing of timber and wood products constitute the principal industry of the basin. Agriculture is of importance in the lower valley. The main agricultural products are livestock, dairy and poultry products, and fruits and vegetables.

The lower reaches of the Lewis River basin have been extensively developed for hydropower production. These developments include the Merwin, Yale, and Swift No. 1 projects, owned and operated by the Pacific Power & Light Company and the Swift No. 2 project owned by the Public Utility District No. 1 of Cowlitz County, Washington. With the exception of Swift No. 2, these developments are storage projects and have a total active storage capacity in excess of 880,000 acre-feet (1,085,000,000 m^3). This storage provides for significant seasonal flow regulation of the Lewis River. In addition to hydroelectric power, the water resources of the basin have been developed for irrigation, flood control, water supply, navigation, and water-based recreation, including hunting and fishing.

The Merwin hydroelectric project, License No. 935, is being considered by the Commission for relicensing or recommendation for Federal takeover. The original license expired on December 11, 1979, and the owner, Pacific Power & Light Company, applied for a new license on May 5, 1976. The owner is currently operating the project on an annual license basis. On February 18, 1977, Clark-Cowlitz Joint Operating Agency (CCJOA) filed a competing application for a new major license to operate the Merwin project, designated Project No. 2791.

Proceedings on these two applications were consolidated by Commission Order on October 18, 1978.

The Merwin project, discussed in detail in chapter V, has an installed capacity of 136,000 kilowatts (including station service) and has produced 539,500,000 kilowatt-hours of average annual energy. The principal features are a 313-foot (95-m) high concrete arch dam with a storage reservoir and a powerhouse structure housing three hydro-turbine generators. The dam creates a reservoir with a surface area of about 4,040 acres (1,635 ha) which extends up the Lewis River about 14.5 miles (23.3 km) at full pool. The reservoir is used extensively for recreational activities. The powerplant is operated at an average capacity factor of 43 percent (with average annual energy related to dependable capacity of 143 megawatts). The project has been well maintained and efficiently operated. No new construction or modification of existing facilities are proposed as part of the application for a new license. Studies performed by the Commission staff indicate that the Merwin project appears economically favorable for continued operation.

Electric power requirements of the basin are supplied by Public Utility District No. 1 of Clark County and Public Utility District No. 1 of Cowlitz County from Bonneville Power Administration's deliveries. There are 518 megawatts of installed hydroelectric generating capacity (all licensed projects) in the basin. Pacific Power & Light Company owns Swift No. 1 (204 megawatts), Merwin (136 megawatts), and Yale (108 megawatts). The Public Utility District No. 1 of Cowlitz County owns Swift No. 2 (70 megawatts). The average annual generation by the basin's hydroelectric plants is nearly 2,000,000,000 kilowatt-hours. There are no steam-electric powerplants within the basin.

The major water resource management problems in the Lewis River basin are related to water quality, groundwater availability, and municipal water supply. Lesser problems include flooding, preservation of instream flow values, and undeveloped water-related recreational potentials. Projected trends of population growth and increase in water requirements for Clark County and Vancouver, Washington, in general, point to an increasing demand for water supply diversions from the Lewis River.

Seventeen potential conventional hydropower sites have been identified in the Lewis River basin. The potential annual generation at each of these individual projects is under 420 gigawatt-hours, with 114 gigawatt-hours being the average annual individual site potential. Economic data for most of these sites will become available upon completion of the Corps of Engineers' National Hydropower Inventory Study. Staff studies indicate that the undeveloped site most likely to be economically feasible is the Muddy development. Seven sites for the potential development of pumped storage hydroelectric power have been identified. However, because of the existence of and opportunities for conventional hydroelectric power for peaking in the Northwest, pumped storage developments may continue indefinitely to be impractical in the region.

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CHAPTER I

DESCRIPTION OF THE BASIN

Location and Terrain

The Lewis River basin is located in Southwestern Washington State and occupies approximately 1,046 square miles (2,709 km^2) in Clark, Cowlitz, and Skamania Counties. The Lewis River joins the lower Columbia River about 19 miles (31 km) north of Vancouver, Washington. Its watershed occupies most of the area lying between the Cascade Ridge on the east, the Columbia River on the south and west, and the Kalama and Cowlitz River basins on the north. The Lewis River originates at Adams Glacier on the northwest face of Mt. Adams -- elevation 12,307 feet (3,751 m) msl -- and flows in a southwesterly direction 94 miles (151 km) to join the Columbia River near Woodland, Washington, at near sea level elevation and about 85 miles (137 km) upstream from the mouth of the Columbia River. In this distance, the river has a fall of about 7,900 feet, the greatest part of the fall being in the upper reaches.

Principal tributaries are Siouxon, Swift, Pine, Canyon, and Cedar Creeks, and East Fork Lewis and Muddy Rivers. The East Fork has the largest drainage area, flowing parallel to and on the south of the Lewis River until it joins the Lewis River about 3 miles (5 km) from the mouth.

The Lewis River basin is characterized by rough topography and is heavily forested with about half the area in national forest. High benches of comparatively level land, generally in forest, are situated in the south central portion of the basin. Lower reaches of the Lewis River are bordered by small areas of level bottoms. Stream gradients for the Lewis River range from about 4 percent in the upper reaches to a low of one-quarter of 1 percent near its mouth.

Climate and Hydrology

The climate of the Lewis River basin is characterized by mild, wet winters and cool, dry summers. Freezing weather is rare in the lower basin, but lower temperatures prevail in the mountainous sections, where there are perennial snows and glaciers. The frost-free growing season averages about 200 days in the arable portions of the basin, with the last killing frost in the spring about April 24 and the first in the fall about November 10. Extensive arable lands to the south of the basin have a longer growing season.

Annual precipitation varies greatly, depending on locale, and is directly related to elevation. Mean annual precipitation ranges from a minimum of 35 inches (89 cm) along the Columbia River to a maximum of about 140 inches (360 cm) in the Summit area of Mt. St. Helens. Only 20 percent of the annual precipitation occurs during April through September, with July and August receiving less than 5 percent of the annual rainfall. Snowfall varies from an average of some 10 inches (25 cm) annually in the lower basin to more than 100 inches (254 cm) in the mountainous portions.

Normal daily temperatures in summer range from 70 degress Fahrenheit (21°C) to 80 degrees Fahrenheit (27°C) in the lower areas, and 60 degrees Fahrenheit

(16°C) to 70 degrees Fahrenheit (21°C) in the mountains. In winter, minimum daily temperatures range from 45 degrees Fahrenheit (7°C) in the lower area, down to 0 degree Fahrenheit (-18°C) in the mountains.

Lewis River discharges have been measured by the U.S. Geological Survey at Ariel (near the Merwin Dam) continuously since 1923. The average annual flow during this period has been 4,875 cubic feet per second (138 m^3/s) with the maximum and minimum annual flows being 7,065 cubic feet per second (200 m^3/s) and 2,840 cubic feet per second (80 m^3/s), respectively. The flows of the East Fork of the Lewis River, where the U.S.G.S. has measured flows since 1929, are considerably smaller than those of the main stem. The drainage area at that gage is 125 square miles (325 km^2). The average annual flow is about 746 cubic feet per second (21 m^3/s), with maximum and minimum annual discharges being 1,065 cubic feet per second (30 m^3/s) and 462 cubic feet per second (13 m^3/s), respectively. For comparison, the Columbia River at Vancouver has an average annual streamflow of about 198,888 cubic feet per second (5,632 m^3/s) and a drainage area of 241,000 square miles (624,000 km^2).

Peak flows of the Columbia River, the largest river in western North America, occur in the months of April, May, June, and July as a result of runoff from melting snow. In contrast, the peak flows of the tributaries in the Lower Columbia region, including the Lewis River, occur in November, December, and January as a result of the increased runoff from rainfall. Accordingly, Lewis River flooding does not coincide with flood peaks of the Columbia River past Bonneville Dam.

Water Quality

Water in the Lewis River basin is low in dissolved solids and chemical constituents and is generally of excellent quality. In the upper basin, however, poor logging practices periodically cause localized areas of decreased quality. In the watersheds draining into Swift, Yale, and Merwin Reservoirs, quality is normally ideal. At the lower end of the East Fork of the Lewis River, where farming and residential development are more extensive, quality levels are lower but still acceptable for existing uses. In general, both surface and groundwaters are of excellent quality for irrigation. Irrigation has had little effect on the quality of water supplies.

As a result of the spring snowmelt on the slopes of Mt. Adams and Mt. St. Helens, the Lewis River, and occasionally the Muddy River, run milky white with glacial flour during the late spring and summer.

With the exception of the Willamette River, the overall effect of the tributaries on the quality of the lower Columbia River is slight. Most of this area is underlain by volcanic rocks which are resistant to solution. Consequently, all of the streams are low in dissolved minerals.

CHAPTER II

PRIOR REPORTS AND CURRENT INVESTIGATIONS

Prior Reports

Much of the information used in this report was obtained from prior reports made available by various Federal, State, and local agencies. Those reports having a direct and important bearing on the water resources development of the Lewis River basin are briefly described below.

"Columbia-North Pacific Region, Comprehensive Framework Study of Water and Related Lands," including a main report, summary report, and 16 appendices, was prepared by State and Federal agencies under the aegis of the Pacific Northwest River Basins Commission. It presents the results of comprehensive investigations of water and related land resources of the Columbia-North Pacific region. The release dates on various reports vary from 1970 through 1972.

"Pumped Storage in the Pacific Northwest, and Inventory," January 1976, was prepared by the North Pacific Division, U.S. Army Corps of Engineers, Portland, Oregon, as an element of the Columbia River and Tributaries Review Study.

The "Southwestern Washington River Basin Type IV Survey," 1974, was prepared jointly by the United States Department of Agriculture Soil Conservation Service, Economic Research Service, the Forest Service, and the State of Washington. The Survey consists of an area-wide report which describes the natural resources of the region and discusses economic development, water and related land resource problems, existing programs, and solutions to problems and needs.

The Gifford Pinchot National Forest staff prepared a number of area Part One Land Use Plan Final Environmental Statements. Reports pertinent to the Lewis River basin are the "Clear Creek Planning Unit," October 1976; "Upper Lewis River Planning Unit," November 1976; and "Trapper-Siouxon Planning Unit," September 1977. The proposed management plan provides for most resource uses. "Geothermal Leasing and Development, Gifford Pinchot National Forest," January 1979, is an evaluation of the impacts of geothermal leasing on all national forest resources and development to control and minimize adverse impacts.

"Lewis River Basin, Washington, Reconnaissance Report," dated October 1950, was prepared by the Bureau of Reclamation (now the Water and Power Resources Service). The report is a summary of potential resource developments in the Lewis River basin. It concluded that there were no project possibilities within the basin, and further detailed study was deferred at that time. However, the Bureau, in a 1979 transmittal of the report to the FERC San Francisco Regional Office, stated that the conclusions of the report may no longer be valid in light of current needs, resource status, and planning criteria. Nevertheless, the Water and Power Resources Service does not anticipate scheduling further studies of the area.

The "Hydrographic Atlas, Lewis River Basin Study Area" and the "Technical Supplement to the Hydrographic Atlas, Lewis River Basin Study Area," October 1973, were prepared by John F. Orsborn and Mohinder N. Sood of the R.L. Albrook

Hydraulic Laboratory, Department of Civil and Environmental Engineering, Washington State University, through the State of Washington Water Research Center for the Washington State Department of Ecology as part of the State Water Program.

"Report for Selection of Plant, Yale Hydroelectric Expansion for Pacific Power & Light Company," dated July 1974, was prepared by Ebasco Services Incorporated. It presents a plan for the combination hydroelectric and pumped storage expansion of the generating capability at the existing Yale hydroelectric project on the Lewis River.

"Investigation, Swift-Yale Pumped Storage," dated October 1974, was prepared by Cornell, Howland, Hayes & Merryfield, Engineers-Planners-Economists, for the Public Utility District No. 1 of Cowlitz County. The report concluded that the construction of a Swift-Yale pumped storage project appeared to be feasible from an engineering standpoint. Accordingly, it was recommended that a phased development study program be initiated by the District until project feasibility was firmly established.

An engineering report, "Long-Range Water Supply Study for Public Utility District No. 1 of Clark County, Washington," dated June 1966, was prepared by R.W. Beck and Associates, Consulting Engineers. This is a survey and study of the present and future water requirements of Clark County and the sources of supply which may be available to serve those requirements. R.W. Beck and Associates also prepared a report for the City of Seattle titled, "Report on Site Selection Survey," dated July 1977 which included the investigation of four sites in the Lewis River basin.

The Water Resources Planning Act of 1965 (P.L. 89-80) authorizes the Water Resources Council to maintain a continuing study of the Nation's water and related land resources and to prepare periodic assessments to determine the adequacy of these resources to meet present and future water requirements. The Council reported its first national assessment in 1968, which put into nationwide perspective estimates of present and future regional water and related land requirements and supplies. The Second National Water Assessment, published by the Council in December 1978, presents nationally consistent current and projected water use and supply information by regions and subregions for the United States. The second assessment found that significant achievements have been made in the past decade in preserving water and harnessing its power from a growing interest in water conservation and environmental protection; and that greater efforts are needed to insure careful management of our water resources and to solve the complex water and related land problems which still exist. A supplemental report to the second assessment, Water for Energy, provides information on energy and related water requirements at the region and subregion level for the years 1975, 1985, and 2000, including cooling water requirements for steam-electric generation.

Current Investigations

The Corps of Engineers is working on the National Hydroelectric Power Study authorized under Public Law 94-587 (October 22, 1976). It is investigating 4 existing sites and 16 undeveloped sites for hydropower potential within the Lewis River basin. This study is expected to be completed by September 30, 1981. In addition, the Corps of Engineers is assisting the Federal Emergency Management Agency (FEMA) in the preparation of a flood insurance study for Clark County. FEMA is expected to publish the final draft of the flood insurance study in 1980.

CHAPTER III

ECONOMY OF THE BASIN

General

The present economy of the Lewis River basin can be divided into three geographic parts. The first part is located from the mouth of the Lewis River eastward to Woodland, Washington. Here the major economic pursuits include the production of livestock, dairy and poultry products, and the growing of fruits and vegetables. Woodland, as shown on figure 2, is the only community in the basin accessible by interstate highway, a waterway used for commerce, or a major railroad. The second part extends eastward from Woodland to Merwin Dam. The economy in this section is represented mainly by single-family residences with occasional cattle grazing areas. The third area lies eastward above the Merwin Dam. Large timber companies hold most of this property and are actively logging in Clark County.

Minerals of economic importance found in the basin include sand, gravel, and volcanic rock.

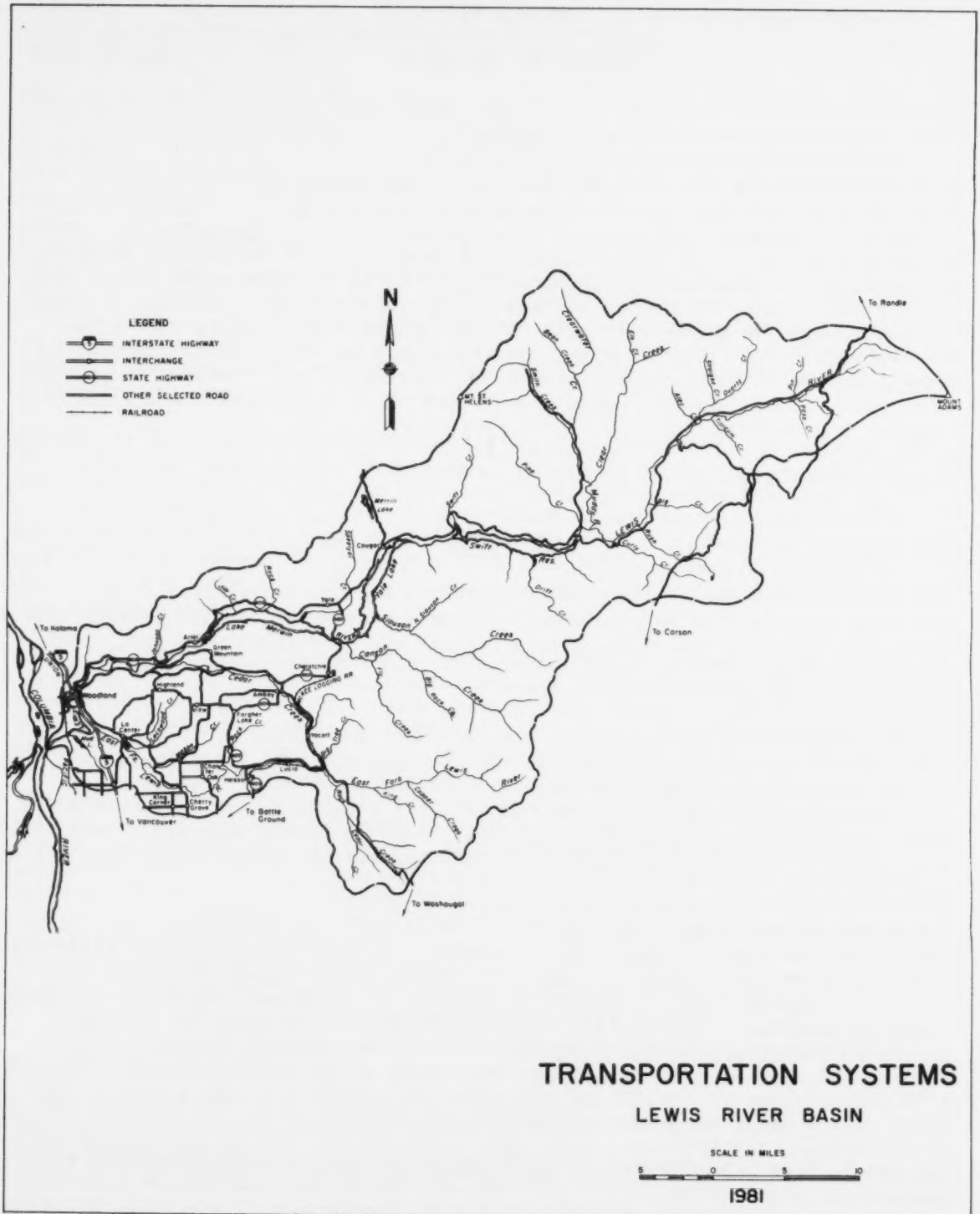
Recreation

The Lewis River basin is a popular recreation area for residents of the Portland, Oregon, metropolitan area -- being approximately 1-hour driving time away. The basin is suitable for both day use and overnight recreation. Recreation opportunities in the basin are diverse, and many facilities have been built to accommodate visitors.

Camping, picnicking, fishing, boating, swimming, and hiking are popular activities. Other recreational activities include sightseeing, photography, golf, and berrypicking in season. Whitewater activities and winter sports are becoming increasingly popular. Upstream of Swift Reservoir, the Lewis and Muddy Rivers are used for rafting and kayaking. Cross-country skiing and snowmobiling are popular within the Gifford Pinchot National Forest, where marked trails are provided.

Since many of the recreation facilities are either free or inexpensive, the more than 1,000,000 visitors who annually utilize the basin constitute a significant, although difficult to measure, impact on the basin's economy. However, one measure of the economic importance of recreation is the expenditure of the land-managing agencies in the basin. The U.S. Forest Service budgeted $61,000 for recreation expenditures for 1979, and Pacific Power & Light budgeted $285,000 for the same period. The Washington Department of Natural Resources estimated 1978 expenditures of $50,000 for its seven recreation developments in the basin. Clark County had a projected 1979 budget of $117,000 for the county's three parks in the basin. In 1978, the county spent $200,000 for capital improvements at Lewisville Park and $400,000 for development of the newly-opened Moulton Falls Park.

The basin contains over 300 summer homes located on various tracts throughout the basin. Current selling prices range from $30,000 to $50,000 for homes



F E R C – Water Resources Appraisal for Hydroelectric Licensing

Figure 2

located on lands leased from the Forest Service or other landowners. The few summer homes available on private lands cost from $65,000 to $80,000. One private development in the basin contains 1,500 recreational vehicle sites which are sold to individuals at prices ranging from $2,000 to $20,000 with annual dues of $160.

Primary access to the basin is through the City of Woodland which benefits from the increased traffic flow and stimulation to the local economy by recreationists.

The Washington Department of Game estimates the economic value of spring and fall chinook in the basin to exceed $2,000,000 annually. Economic data for other fish and wildlife species are not available.

A description of the recreation facilities is presented in chapter IV.

Electric Utility Service and Coordination

Electric power requirements of the basin are supplied by Public Utility District No. 1 of Clark County (CLCU) and Public Utility District No. 1 of Cowlitz County (COCP). The portion of the basin in Skamania County is a mountainous wilderness area and has very little power requirements.

Most of the electric loads are located in the western portion of the basin in CLCU and COCP service areas of the Public Utility District No. 1 of Clark County and the Public Utilty District No. 1 of Cowlitz County. These service areas include several small communities and rural areas. The total 1970 population in both service areas was less than 10,000.

There are 518 megawatts of installed hydroelectric capacity (all licensed projects) in the basin. Pacific Power & Light Company owns Swift No. 1 (204 megawatts), Merwin (136 megawatts), and Yale (108 megawatts). The Public Utility District No. 1 of Cowlitz County owns Swift No. 2 (70 megawatts). However, since the operation of Swift Nos. 1 and 2 are closely coordinated, the Public Utility District No. 1 of Cowlitz County and the Pacific Power & Light Company agreed to split the plants' combined output in approximate proportion to the size of their respective projects. By this agreement, the Public Utility District No. 1 of Cowlitz County is entitled to 26 percent of the total output from Swift Nos. 1 and 2, and the Pacific Power & Light Company is entitled to the remaining 74 percent. Currently, the Public Utility District No. 1 of Cowlitz County is selling its entitlement to Pacific Power & Light Company, subject to withdrawal upon 3 years notice.

One 230-kilovolt transmission line delivers the Swift projects' output to Bonneville Power Administration's (BPA) 230-kilovolt Lexington-J.D. Ross line, and thence to BPA's 230-kilovolt grid. Two 115-kilovolt lines deliver Yale and Merwin projects' output -- one line transmits power from the Merwin project to BPA's Cardwell substation, and the other delivers power to Pacific Power & Light Company's St. Johns substation. There are two Public Utility District No. 1 of Clark County 115-kilovolt short taps; one is from the 115-kilovolt Yale-Merwin line to BPA's Chelatchie substation, and the other is from the 115-kilovolt Merwin-St. Johns line to View substation. The average annual generation by the basin's hydroelectric plants is estimated at 1,966,500 megawatt-hours.

The principal electric facilities located in the Lewis River basin are shown on figure 3.

Both the Pacific Power & Light Company and the Public Utility District No. 1 of Cowlitz County are members of the Western Systems Coordinating Council. The Public Utility District No. 1 of Clark County is an affiliate member of the Council. The Council, formed in 1967, was the first regional reliability council organized in the United States and is now 1 of 9 electric reliability councils in the lower 48 States. The principal goal of the Council is the promotion of reliable operation of the interconnected bulk power supply systems in the western United States and British Columbia, Canada, through coordinated planning and operation of the region's generating and transmission facilities.

The Pacific Power & Light Company is also a member of the Northwest Power Pool. The Pool is an organization of utilities and agencies which voluntarily operates their power systems on a coordinated basis. The operating organization of the Pool consists of an Operating Committee and a Coordinating Group. Considerable effort is devoted to making load-resources analyses for both the coordinated systems of the Pacific Northwest Coordination Agreement and of the Northwest Power Pool. The membership of the Pool in 1977 included the following 19 utilities and agencies:

Bonneville Power Administration
British Columbia Hydro & Power Authority
Chelan County Public Utility District
Corps of Engineers, U.S. Army
Douglas County Public Utility District
Eugene Water & Electric Board
Grant County Public Utility District
Idaho Power Company
Montana Power Company, The
Pacific Power & Light Company
Portland General Electric Company
Puget Sound Power & Light Company
Seattle City Light
Tacoma City Light
Utah Power & Light Company
Washington Public Power Supply System 1/
Washington Water Power Company, The
Water and Power Resources Service
West Kootenay Power & Light Company

1/ CLCU and COCP are members of Washington Public Power Supply System.

The Intercompany Pool (ICP) is an organization made up of investor-owned utilities operating in the Northwest. Headquarters of the ICP are located in Spokane, Washington. In the Pool's office each company's scheduling representative works with the others, coordinating the hourly and daily operation of his system's generation and transmission facilities. The ICP has a permanent staff. Its main function is to coordinate the planning of the long-range generation and transmission projects initiated by the ICP companies. The seven members of the Pool are:

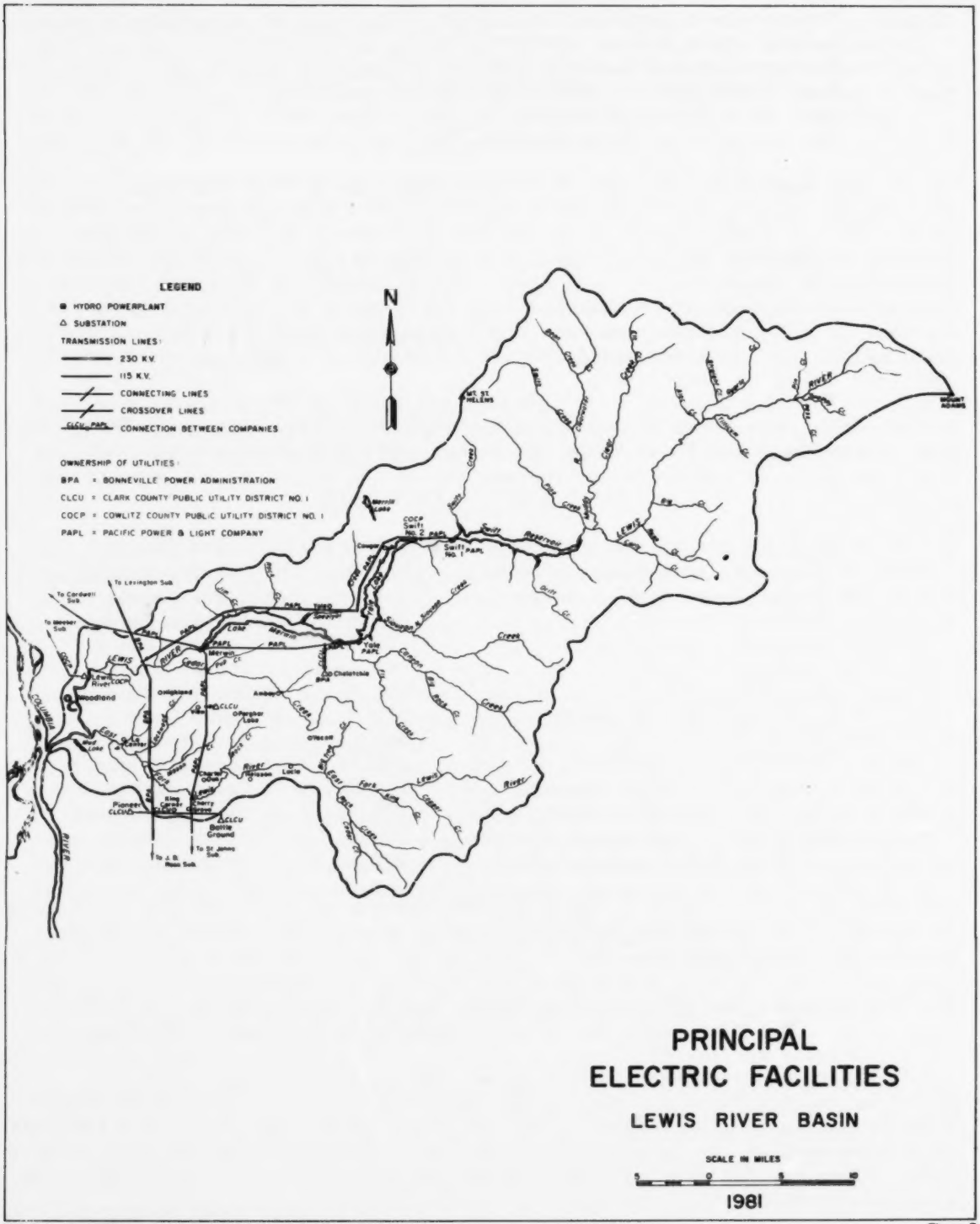


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Figure 3

Idaho Power Company
Montana Power Company, The
Pacific Power & Light Company
Portland General Electric Company
Puget Sound Power & Light Company
Utah Power & Light Company
Washington Water Power Company, The

The Pacific Northwest Utilities Conference Committee (PNUCC) was organized in 1946 for the purpose of coordinating regional power planning and providing regional support from electric utilities for the Federal Columbia River power program. Membership included public and private utilities, with the Bonneville Power Administration and the U.S. Army Corps of Engineers providing the basic program planning. Also, to meet the need for a regional loads and resources forecast, a PNUCC subcommittee was formed to prepare annually a 10-year forecast. PNUCC and its Loads and Resources Subcommittee have continued to carry out these and other functions.

Current PNUCC membership includes the following utilities within the West Group Area of the Northwest Power Pool; the Bonneville Power Administration and the U.S. Army Corps of Engineers are represented on the committee but are not members:

Central Lincoln Peoples Utility District	PUD No. 2 of Grant County
City of Eugene Water & Electric Board	PUD No. 1 of Clallam County
City of Forest Grove Light & Power	PUD No. 1 of Clark County
City of McMinnville	PUD No. 1 of Cowlitz County
City of Seattle	PUD No. 1 of Benton County
City of Tacoma	PUD No. 1 of Chelan County
Idaho Power Company	PUD No. 1 of Douglas County
Milton-Freewater Light & Power	PUD No. 1 of Ferry County
Montana Power Company, The	PUD No. 1 of Klickitat County
Pacific Power & Light Company	PUD No. 1 of Franklin County
Portland General Electric Company	PUD No. 1 of Grays Harbor County
Puget Sound Power & Light Company	PUD No. 1 of Kittitas County
Washington Public Power Supply System	PUD No. 2 of Grant County
Washington Water Power Company, The	PUD No. 1 of Snohomish County

The loads of other utilities, which are not members of the PNUCC but serve load in the West Group Area, are included in the load estimates of the utilities which supply their requirements.

The load area for the PNUCC is considered the West Group Area of the Northwest Power Pool. This area comprises all of the State of Washington; the northern Idaho panhandle and the BPA loads in southern Idaho; Oregon, except for Malheur County and the southeastern part of Baker County; northern California now served by Pacific Power & Light Company (formerly served by California-Oregon Power Company until the merger of the two companies in July 1961); and the area in Montana west of the Continental Divide (which overlaps into the East Group Area), where Pacific Power & Light Company and Bonneville Power Administration have service loads.

inter-utilities arrangements have accomplished much toward this end. These efforts culminated in the Pacific Northwest Coordination Agreement, a formal contract for coordinating the operation of the hydroelectric generating resources of the member systems for the best utilization of their collective reservoir storage. Finalized in mid-August 1964, the Agreement became effective on January 4, 1965, and terminates on June 30, 2003. The following 16 agencies and utilities have ratified the Agreement:

Bonneville Power Administration
Corps of Engineers
Chelan County PUD
Colockum Transmission Company
Cowlitz County PUD
Douglas County PUD
Eugene Water & Electric Board
Grant County PUD
Montana Power Company, The
Pacific Power & Light Company
Pend Oreille PUD
Portland General Electric Company
Puget Sound Power & Light Company
Seattle City Light
Tacoma City Light
Washington Water Power Company, The

The power area for the Coordination Agreement is a composite of the service areas of the member utilities, with the exception of The Montana Power Company east of the Continental Divide and the BPA service area in southern Idaho.

Water Availability and Use

The uses of surface water are mostly instream and nonconsumptive, such as for the production of hydroelectric power and the rearing of fish in hatcheries. Groundwater sources provide the bulk of the municipal, industrial, and irrigation requirements of the basin.

The quantity of water produced in the basin is high, as is typical of the west side of the Cascade Range. Most of the runoff occurs during the winter rainy season and in the spring snowmelt. At these times, the streams typically run bank-full. During the dry summer months from July into September, streamflows are much less. Flow variability in the Lewis River is decreased by the effects of natural storage in snowfields, glaciers, and groundwater reservoirs, and by regulation provided from upstream hydropower reservoirs. The glaciers tend to regulate streamflow by accumulating and storing precipitation during cold, wet years and releasing more than average amounts of water during hot dry years.

Water use for irrigation varies from year to year, depending on the amount of precipitation received during the growing season. In many instances, irrigation is used to prevent crop failure and to maintain plant growth rather than to produce optimum yields. In dry years, the amount of water applied per acre is somewhat greater than in average years.

CHAPTER IV

EXISTING WATER AND RELATED LAND RESOURCES DEVELOPMENT

General

The water resources of the Lewis River basin have been developed for hydroelectric power, irrigation, flood control, water supply, navigation, and water-based recreation. The locations of the various dams and reservoirs in the basin are shown on the Basin Map, figure 4, and the Basin Profiles, figure 5. Surface and groundwater sources provide good quality water for domestic, municipal, and industrial uses. Existing water resource developments which provide the foundation for future resource planning are discussed in the following paragraphs.

A combination of land treatment measures, water control installations, and improved watershed management practices has been applied on cropland, forest land, and rangeland to achieve the best use and conservation of these areas, so that the social and economic needs of the area are met. Some of the more identifiable results obtained from these practices are overall reduction in sediment yield, more intensive use of croplands, improved range condition and capacity, decreased erosion and sediment problem areas, relief in flood and drainage problems, and improved water quality and water yields.

Irrigation and Drainage

Irrigation has been needed in the agricultural development of the fertile alluvial soils of the Lewis River. Problems associated with expansion of irrigation relate primarily to physical limitations of the land resource, although economic considerations are also important factors. Less than 8 percent of the lands in the basin have an excess water problem. They are characterized by poor soil drainage, wetness, a high water table, and flooding.

Flood Control

Damaging floods can occur anytime between December and the end of May. Winter floods are the result of rain and warming temperatures which melt snow at the lower elevations. Spring floods are usually caused by melting snow at the higher elevations and from precipitation. High water in the Columbia River can cause backwater flooding along the lower Lewis River. Considerable diking and revetment work has been done from the mouth of Lewis River to Woodland and La Center.

Forecasting is used in flood control operations of reservoirs to provide flood warning and to assure a maximum of stored water for power generation, municipal use, and irrigation.

Hydroelectric Power

The lower reaches of the Lewis River have been extensively developed for hydropower production. These developments include the Merwin, Yale, and Swift No. 1 projects, owned and operated by the Pacific Power & Light Company and the Swift

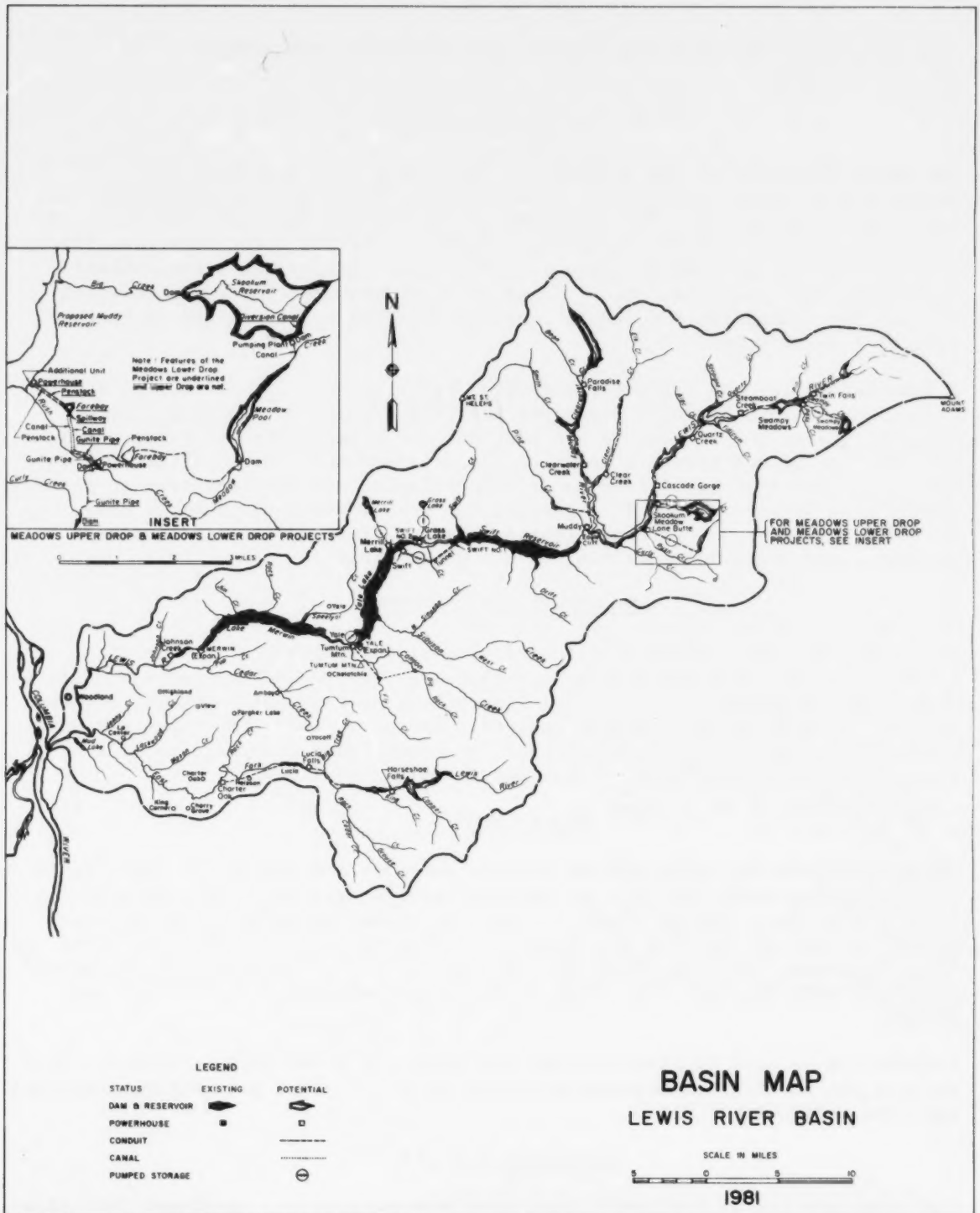

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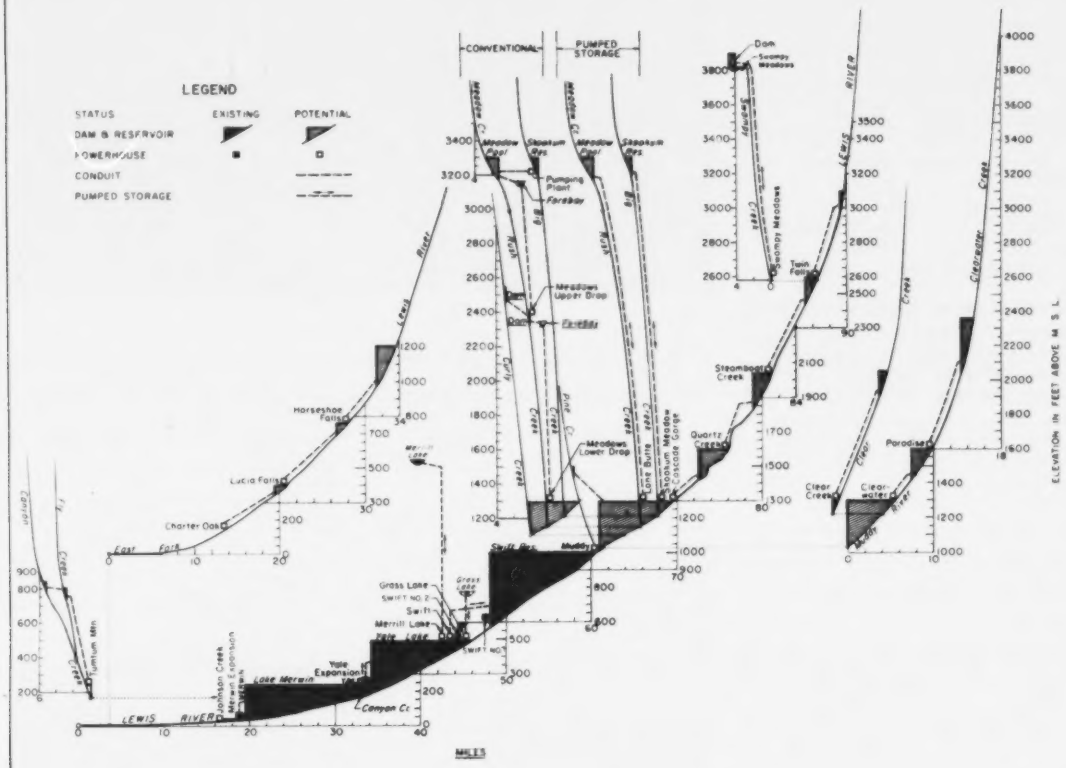
Figure 4



BASIN PROFILES

LEWIS RIVER BASIN
1981

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Figure 5

Swift No. 2 project owned by the Cowlitz County Public Utility District No. 1 and operated by the Pacific Power & Light Company. With the exception of Swift No. 2, these developments are storage projects and have a total usable storage capacity in excess of 880,000 acre-feet (1,085,000,000 m^3). This amount of storage capacity is sufficient to provide for significant seasonal flow regulation of the Lewis River. Table 1 contains project data for the hydroelectric plants.

Table 1

Hydroelectric Project Data
Lewis River Basin

Project	Merwin	Yale	Swift No. 2	Swift No. 1
FERC Project No.	935	2071	2213	2111
License Expiration Date	Dec. 11, 1979	Apr. 30, 2001	Apr. 30, 2006	Apr. 30, 2006
River Mile	19.6	34.2	44.2	47.9
Drainage Area, sq mi (km^2)	731 (1,893)	600 (1,554)	481 (1,246) 1/	481 (1,246)
Average Annual Discharge, cfs (m^3/s)	4,825 (137)	3,940 (112)	2,919 (83)	2,919 (83)
Height of Dam Above Foundation, ft (m)	313 (95)	323 (98)	--	512 (156)
Gross Reservoir Capacity, ac-ft	422,800	401,760	--	755,580
Gross Reservoir Capacity, (m^3)	(522,000,000)	(496,000,000)	--	(932,000,000)
Total Power Storage Capacity, ac-ft	263,800	189,500	--	447,000
Total Power Storage Capacity, (m^3)	(325,400,000)	(234,000,000)	--	(551,000,000)
Normal Max. Pool Elevation, ft (m) msl	239.6 (73.0)	490 (149)	604 (184)	1,000 (305)
Normal Max. Head, ft (m) msl	192 (59)	250 (76)	114 (35)	396 (121)
Installed Capacity, MW	136 2/	108	70	204
Average Annual Generation, MWh	539,500	550,000	240,000	642,000
Initial Operation, year	1931	1953	1958	1958

1/ *Effective.*
2/ *Includes one 1-MW station service unit.*

Downstream from river mile 61, the Lewis River leaves the heavily wooded canyon of Gifford Pinchot National Forest and enters Swift reservoir (Project No. 2111) at an elevation of 1,000 feet (305m) msl. From Swift No. 1, the river is diverted through a canal to Swift No. 2 (Project No. 2213). Immediately downstream the river enters Yale Lake (Project No. 2071) at an elevation of 490 feet (149m) msl. Continuing on downstream, the river enters Lake Merwin at river mile 34 (Project No. 935) at an elevation of 240 feet (73m) msl. This point is 29 miles (47km) east of Woodland, Washington, which is located on Interstate 5 about 28 miles (45km) north of Portland, Oregon.

The license for the Merwin project expired on December 11, 1979. It is currently operating on an annual license basis and is presently being considered for relicensing, licensing to another applicant, or Federal takeover and is described in detail in chapter V. The following paragraphs offer brief descriptions of the other hydroelectric power developments in the basin.

Swift No. 1 (Project No. 2111)

The project is the uppermost hydroelectric development on the Lewis River. The earthfill dam is 512 feet (156m) high and creates a reservoir 12 miles (19m)

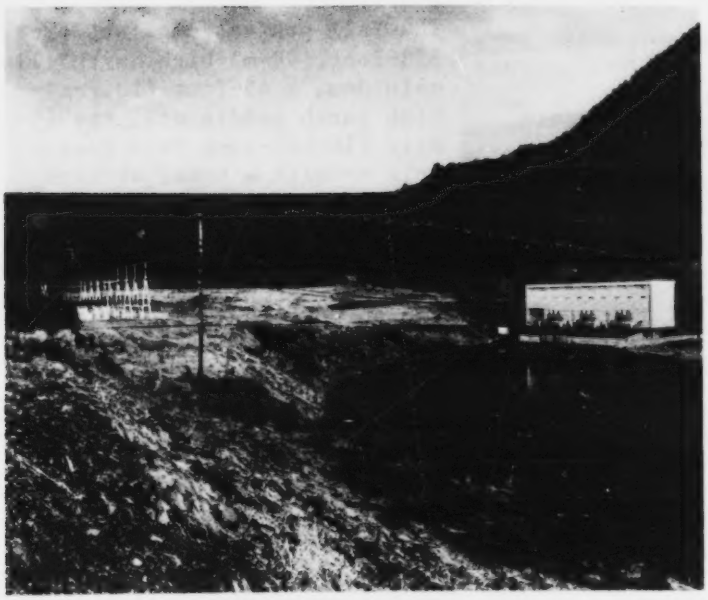

Figure 6. Swift No. 1 Dam and powerhouse.

long with a total storage capacity of 755,500 acre-feet (931,900,000 m^3) at elevation 1,000 feet (305m) msl. Active storage capacity is 447,000 acre-feet (551,000,000 m^3). It has an indoor steel powerhouse structure containing three 117,000-horsepower Francis turbines, each driving a 68,000-kilowatt generator -- for a total rated output of 204 megawatts. The plant operates under a rated head of 378 feet, and the normal maximum gross head is 396 feet (121m). Figure 6 is a photograph looking upstream at the dam and powerhouse.

Swift No. 2 (Project No. 2213)

The project includes a 3.5-mile-long (5.6 km) power canal from Swift No. 1 and a concrete powerhouse, containing two Francis turbines -- each rated at 46,000 horsepower and each connected to a 35,000-kilowatt generator.

There is no water storage in the power canal nor is any storage owned in conjunction with this facility. The exclusive source of water in this power canal is the discharge from turbines at the powerplant of Swift No. 1 project; none of the water spilled at Swift No. 1 is available to Swift No. 2 for generation.

The Swift No. 2 project is owned by the Public Utility District No. 1 of Cowlitz County, Washington, but under the terms of a long-term contract the entire output of this plant is purchased by the Pacific Power & Light Company. The project is operated and maintained by the Pacific Power & Light Company. A view of the powerhouse is shown on figure 7.

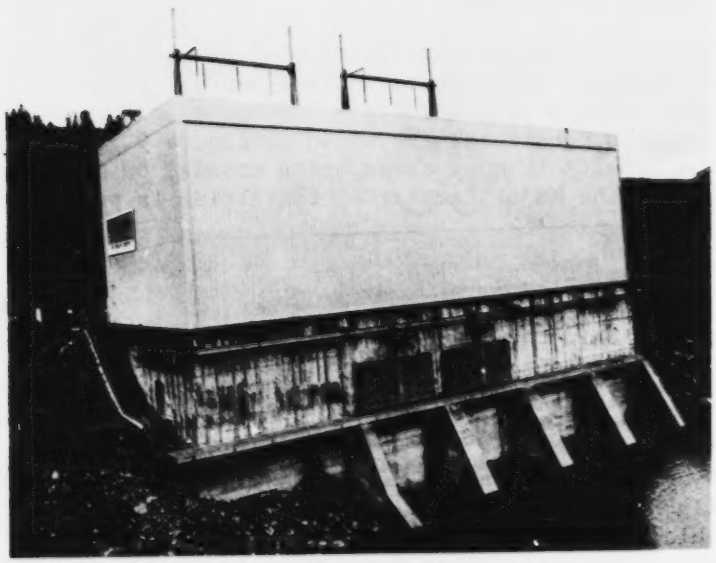

Figure 7. Swift No. 2 powerhouse.

Figure 8. Yale Dam and powerhouse.

Yale Project No. 2071

The Yale project consists of a 323-foot (98-m)-high earthfill main dam, a 45-foot (13.7-m)-high earth saddle dam, the 10-mile (16-km)-long Yale reservoir -- with a total storage capacity of 401,760 acre-feet (496,000,000 m^3), and a powerhouse. The powerhouse is the semi-outdoor type and houses two units with a total rated capacity of 108 megawatts. Figure 8 is an overview photograph of the project's main features.

Water Supply

The primary surface water uses within the Lewis basin include hydroelectric development, fisheries, and recreation; the primary groundwater uses include municipal and industrial water supply, and irrigation. Municipal water supply systems store excess available groundwater in surface impoundments in order to meet peak summer demands. Irrigation requirements are supplied predominantly from groundwater sources, supplemented somewhat from surface water diversions.

Recreation Facilities

The Lewis River basin contains many recreation facilities operated by public agencies, Pacific Power & Light Company, and private entrepreneurs. These facilities make an important contribution to the basin's economy as discussed in chapter III. The major recreation facilities are shown on figure 9. Current demand for recreation facilities results in most areas being crowded on major holiday weekends. A description of the major recreation facilities is provided below.

U.S. Forest Service

Portions of the basin are located within the St. Helens District of the Gifford Pinchot National Forest. Numerous developed recreation sites are available in the National Forest along with unlimited recreational opportunities outside developed sites.

The headwaters of the Lewis River originate in the Mt. Adams Wilderness area. Within that area are many trails, including part of the Pacific Crest National Scenic Trail. No motorized vehicles are allowed in the area, and the management goal is to preserve the area's pristine character. Recreation use in 1978 totaled 55,000 visitor-use days for the Mt. Adams wilderness area, but only a portion of this recreation use can be attributed to the Lewis River basin.

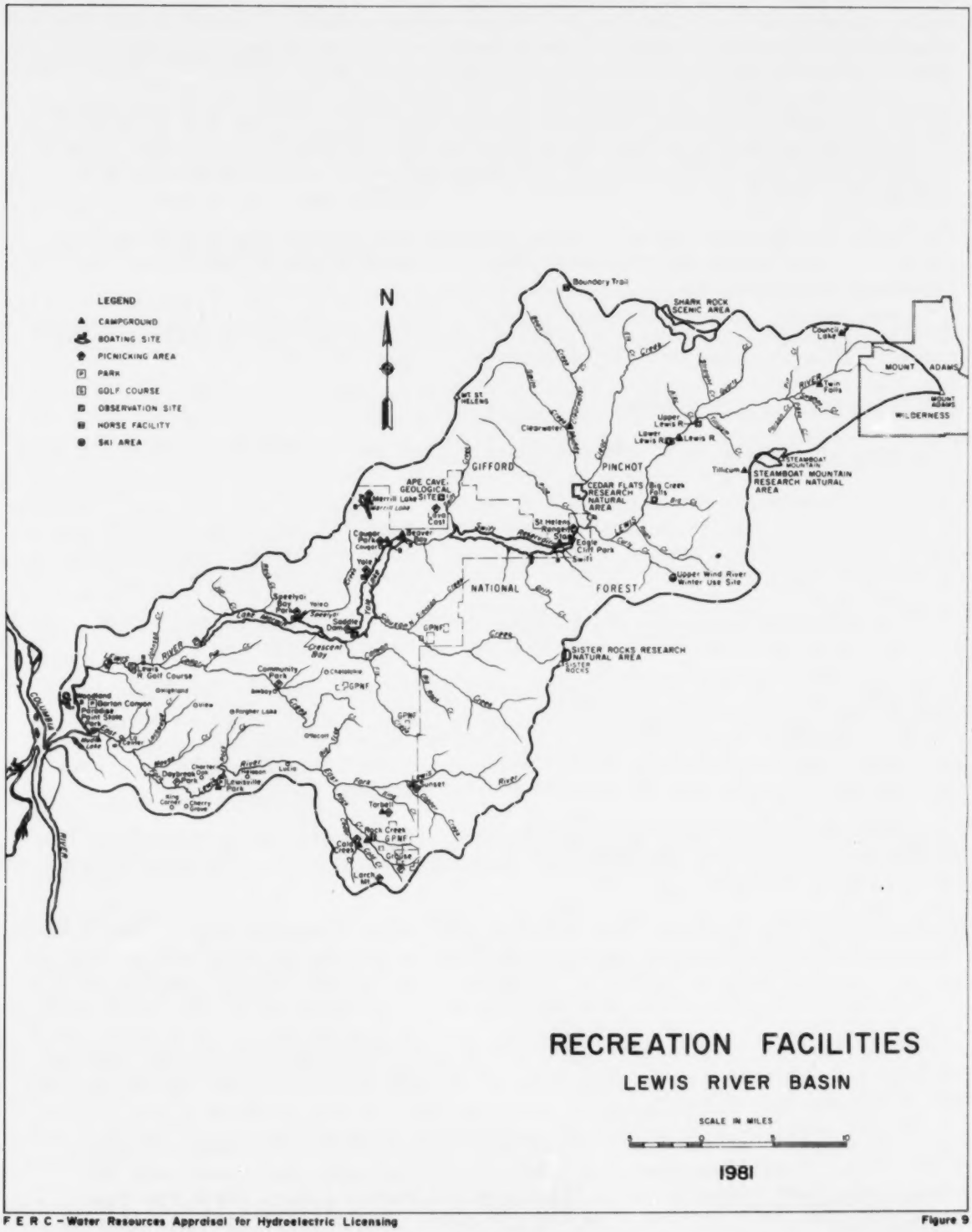

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Figure 9

Within the basin are five developed campgrounds: Tillicum, Council Lake, Twin Falls, Clearwater, and Lewis River. These areas contain a total of over 100 campsites. Accurate recreation use figures are available only for the Clearwater campground which received 64,000 visitor-use days in 1978.

Within the Gifford Pinchot National Forest the Forest Service has designated three natural research areas. Each research area preserves a typical example of an undisturbed timber type. These areas serve as control plots to help analyze the impact of man's activity in the forest.

The Cedar Flat Natural Research Area protects the Douglas Fir-Ponderosa Pine forest. Sister Rocks and Steamboat Mountain areas preserve the alpine fir forest on different soils.

Upstream of Swift reservoir, rafting and kayaking occur on the Lewis and Muddy Rivers. This is a new recreation activity in the basin.

Pacific Power & Light Company

Lake Merwin: Merwin Park, situated near Merwin Dam, operated by Pacific Power & Light Company as a day-use area, contains 135 picnic tables, several cooking shelters, a swimming area, baseball diamonds, and parking for 600 cars. Eleven miles (18 km) upstream from Merwin Park is Speelyai Bay Park. Facilities there include a boat ramp, a boat dock, a picnic area, and a small swimming beach. The area contains 25 picnic tables and parking for 100 cars.

Three private developments, which contain about 60 home tracts and 1,500 recreation vehicle sites, are also located on Merwin reservoir.

Yale Lake: All of the recreation areas at this reservoir are owned and operated by Pacific Power & Light Company. Yale Lake is considered an excellent lake for sailing. Saddle Dam Park is situated near the dam and contains a boat ramp, service dock, ski float, and eight picnic tables. A large gravel parking area is provided for car and trailer parking.

Yale Park is located 2 miles (3 km) farther upstream and contains another 30 picnic sites, a parking area, a boat ramp, and a boat dock. The picnic area has one group shelter.

Four miles (6 km) upstream from Yale Dam are Cougar Park and Cougar Camp which are separated by a bridge. Cougar Park contains 30 picnic sites and a campground. Cougar Camp is a 45-unit campground restricted to tent campers only. A boat launching ramp, dock, and swimming area are adjacent to the campground.

Still farther upstream is Beaver Bay Campground which contains 63 recreational vehicle and 5 picnic sites. The area has a boat launching ramp, swimming area, and a trailer dump station.

Swift Reservoir: At the upper end of the reservoir is Swift Camp and Eagle Cliff Park. Swift Camp contains a boat launching ramp, boat dock, and 101 campsites. Each campsite has a fireplace and picnic table. Near the boat launching ramp is a parking area for 300 cars. Eagle Cliff Park contains 20 picnic tables and is used primarily by fishermen.

On the southeast shore of Swift Reservoir is a 300-unit summer home tract built by private developers.

Washington Department of Parks

The Department of Parks operates the 70-acre Paradise Point State Park on the East Fork of the Lewis River. The park contains 70 overnight campsites, 2 miles (3 km) of hiking trails, a boat launching ramp, and a swimming area. Over 130,000 people visit the park annually. Most visitors are out-of-state residents enroute to other areas.

Washington Department of Natural Resources

The Department of Natural Resources owns substantial land within the basin and operates seven developed recreation areas as described below. Hiking and horseback riding trails exist throughout the department's land holdings.

Merrill Lake is fed by springs and runoff from the surrounding mountains. The lake has no surface outlet, but water discharges through underground channels. The department operates the only facilities on the lake which consist of a boat launching ramp and 12 campsites. Fishing at the lake is restricted to fly fishing.

Three miles (5 km) east of Woodland is the Woodland recreation site located in Bratton Canyon. The site contains 15 picnic sites and a group shelter. Drinking water is also available.

The other recreation facilities are located on the East Fork Lewis River. Larch Mountain and Grouse Creek are vista areas containing seven and five picnic sites, respectively. A panoramic view of the surrounding area can be obtained from these areas. Rock Creek and Cold Creek Camp contain nine campsites each. Tarbell camp contains 18 sites. Horseback riding can be pursued at Rock Creek.

Washington Department of Game

The Department of Game has built two fishing access areas and two boat launching ramps on the Lewis River below Merwin Dam.

Clark County

Clark County operates three parks in the basin which are all located on the East Fork Lewis River.

Lewisville Park is the county's oldest park built in the late 1930's by Works Projects Administration (WPA) workers. The park contains 244 acres (98.7 ha) of meadow and forest lands. Park facilities include picnic areas, hiking trails, and a swimming beach. The park has 15 group picnic shelters which can be reserved during the summer. Recreation use during 1978 exceeded 200,000 visitors.

Daybreak Park is a 7-acre (2.8 ha) meadow containing a swimming beach, boat launching ramp, and picnic area. This park is used primarily by fishermen.

Moulton Falls is the newest park in the county and was dedicated in 1978. The park contains 333 acres (135 ha) located at the confluence of Big Tree Creek and East Fork Lewis River. This site encompasses a historic Indian meeting grounds and railroad site. The park borders both sides of the river for 2-1/4 miles (3.6 km) and is connected by a unique arch foot-bridge. Picnic areas are interspersed throughout the park along an extensive trail system.

City of Woodland

The City of Woodland operates Woodland and Horseshoe Parks, both located in Woodland. Each park contains a boat launching ramp, picnic area, and swimming beach. Outside of Woodland is a 2,600-foot (790 m) long grass landing strip which is used primarily for recreational flying.

Fish and Wildlife

Fish and wildlife are important and valuable resources of the basin. Management practices have concentrated primarily on the basin fishery with anadromous fish receiving the most intensive management. The Washington Department of Game is currently conducting a fish and wildlife study funded by Pacific Power & Light Company. The study will concentrate on the impacts caused by the construction of Pacific Power & Light Company's hydroelectric projects, but it will also discuss fish and wildlife throughout the basin.

The basin is utilized by anadromous fish from the mouth of the Lewis River to Merwin Dam and for 38 miles (61 km) on the East Fork Lewis River, where further upstream migration is blocked by a waterfall. The areas accessible to anadromous fish are used for spawning and rearing of young. Anadromous species found in the basin are spring and fall chinook, coho, and searun cutthroat trout.

The Lewis River supports one of the largest self-sustaining fall chinook runs in the lower Columbia River area. Most of these fish spawn in a 4-mile (6-km) stretch below Merwin Dam. The Washington Department of Fisheries estimates the spawning escapement for the Lewis River fall chinook to average 11,798, from an annual production of 59,256. Spring chinook on the Lewis River have an average spawning escapement of 698 and a total annual production of 3,657. Searun cutthroat utilize some of the same spawning and rearing habitat as coho. Searun cutthroat have a spawning escapement of 2,600 adults.

The Washington Department of Fisheries operates the Speelyai and Lewis River hatcheries in the basin. The hatcheries raise anadromous species for release in the basin and other parts of Washington. These hatcheries are part of the department's statewide salmon enhancement program. In rivers above barriers to anadromous runs, trout and Dolly Varden are the major species found. Many lakes and streams are planted with rainbow, cutthroat, and brook trout. Also, kokanee have been planted in streams entering Merwin, Yale, and Swift reservoirs. Whitefish are found in the East Fork and some streams upstream of Swift reservoir. Other species found in the basin are largemouth bass, perch, crappie, bluegill, pumpkinseed, and bullhead.

Undesirable species of sucker, shiner, stickleback, dace, peamouth, squawfish, and chiselmouth are found in some lowland lakes and reservoirs. Sculpins are distributed virtually throughout all waters.

The Washington Department of Game reports the sandroller, an endangered species, is found in the lower sections of the Lewis River.

Big game is an important product of forest and woodland habitats of the basin. Black-tailed deer, Roosevelt elk, black bear, and cougar inhabit the basin. Most of the Lewis River basin is forested and is below 2,000 feet (610 m) elevation. The 2,000-foot (610-m) contour is the approximate boundary between the summer and winter range for deer and elk. The availability of food and cover on the winter range determines the carrying capacity of the basin for these species. Small clearcuts logged within the last 30 to 50 years provide excellent habitat. The black-tailed deer is the most abundant species with an annual harvest of 300. Black bears are present within the basin, and the population exceeds 500 with an annual harvest of 110.

Over 600 furbearing animals are trapped annually in the basin. Pelts once provided a good source of income, but now trapping is primarily a recreational activity providing supplemental income. The basin contains beaver, muskrat, mink, otter, bobcat, coyote, and raccoon.

The Lewis River basin is primarily a wintering and resting area for waterfowl using the Pacific Flyway. Nesting occurs on perimeters of lakes, marshes, streams, and especially in agricultural areas. Mallard, woodduck, and teal are the major nesting species. Wintering species include mallard, widgeon, pintail, green-winged teal, godwal, shoveler, woodduck, coot, scamp, canvasback, goldeneye, ruddy duck, merganser, Canada geese, and whistling swan. Mallard and widgeon are the most numerous species. The total number of waterfowl using the basin exceeds 150,000 with a winter waterfowl population average of 22,700.

Hunting is a popular activity in the basin. The harvest of deer and elk provides over 114,700 man-days of recreation annually. The hunting of bear and cougar provide another 5,000 man-days. The hunting of grouse, pigeon, and pheasant total over 28,000 man-days and waterfowl hunting total about 15,400 man-days. While hunting recreation is significant, there is evidence that a greater use of wildlife is made by non-hunters than hunters. The most popular non-hunting activities are bird-watching and photography.

CHAPTER V

THE MERWIN PROJECT

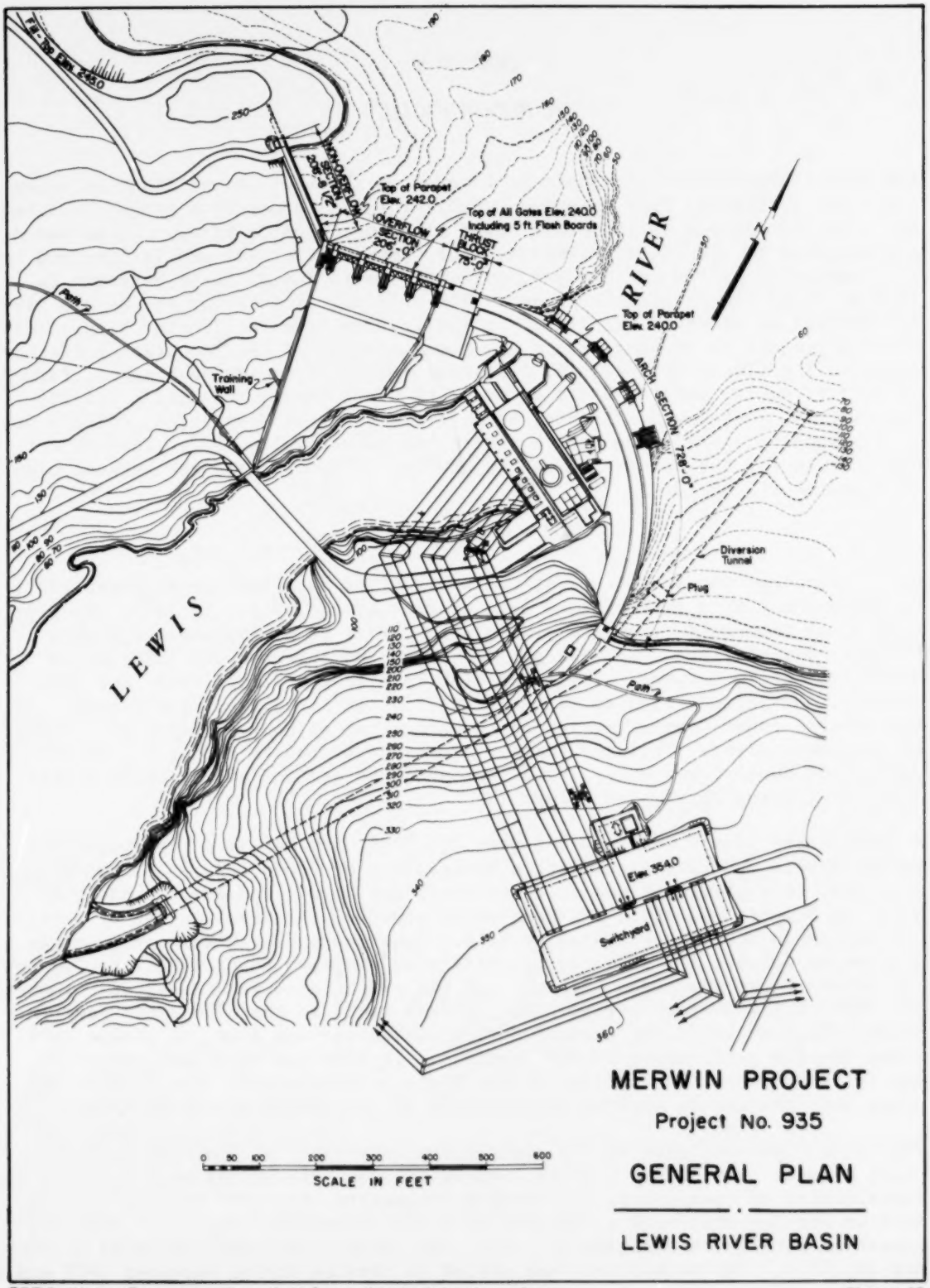
The Merwin hydroelectric project is located on the Lewis River about 14 miles (22.5 km) by highway from Woodland, Washington, and about 19.6 miles (31.5 km) above the confluence of the Lewis River with the Columbia River. It is owned and operated by the Pacific Power & Light Company (Pacific) and is licensed by the Commission as Project No. 935, currently on an annual basis pursuant to section 15 of the Federal Power Act. The original license for the Merwin project expired on December 11, 1979. An application from Pacific for a new license for the project is pending before the Commission as of the preparation of this report. The Clark-Cowlitz Joint Operating Agency, Longview Washington, formed jointly by Public Utility District No. 1 of Clark County and Public Utility District No. 1 of Cowlitz County, both in the State of Washington, filed a competing application for the Merwin project on February 12, 1977. The project was docketed by the Commission as Project No. 2791. The project general plan is shown on figure 10.

History

Water discharge investigations of the Lewis River date back to at least 1909; Merwin project site explorations were started around 1914. In 1922, the Federal Power Commission issued a preliminary permit to Northwestern Electric Company to investigate the Yale project site. On November 24, 1928, Northwestern Electric Company, affiliated with Pacific and Inland Power and Light Company, and Inland filed an expanded application for a preliminary permit with the Federal Power Commission for an investigation of comprehensive development of the Lewis River. This application proposed studies at the Ariel, Basket, Swift, and Muddy Creek sites. The four projects are now known, respectively, as Merwin, Yale, Swift, and Muddy.

A preliminary permit was issued August 15, 1929, for detailed investigations of the Merwin and Yale sites with a designation of Project No. 935. On August 17, 1929, an application was filed to construct Merwin and Yale, Project No. 935. On October 16, 1929, the Commission approved the construction of Merwin but postponed action pertaining to Yale. Construction of Merwin project was started on October 17, 1929, by an affiliated company, Phoenix Utility Company, for Inland Power and Light Company, and the FPC license was issued on December 12, 1929, for a 50-year period. The license required that 760 cubic feet per second (21.5 m^3/s) or the natural inflow, whichever was less, be passed at all times for the maintenance of fish habitat. It also provided that plans for the initial project be approved by the State of Washington. The license has since been revised to approve installation of the second and third units.

The project was designed by the engineering department of Electric Bond and Share Company (now Ebasco Service, Incorporated). Provisions were made for the installation of four units, each having a capacity of 45,000 kilowatts and a station service unit with a capacity of 1,000 kilowatts. The first unit was placed in service on September 4, 1931, and construction was completed on October 16, 1931. The second unit was placed in service during December 1949 and the third unit during 1958. Installation of the fourth unit will be made when the



FERC - Water Resources Appraisal for Hydroelectric Licensing

Figure 10

region's need for peaking capacity materializes. Between 1934 and 1937, the maximum operating pool level was raised from elevation 235 feet (71.6 m) to elevation 239.6 feet (73.0 m) by adding 5-foot (1.5-m)-high flashboards to the top of the spillway gates. Additional modifications were made in 1948 and 1949 that included increasing the height of the parapet and cutoff wall on the gravity section of the dam adjacent to the spillway to elevation 242 feet (73.8 m).

Transfer of Project No. 935 from Inland Power and Light Company to Pacific Power & Light Company was approved by the Federal Power Commission, effective May 14, 1942.

The Ariel-West Vancouver Transmission Line (now part of the Merwin-St. Johns Line) was completed in 1930 by Inland Power and Light Company and initially was used for construction power at the Merwin Dam. The line was constructed for 115 kilovolts but was operated at 66 kilovolts, until the second Merwin unit was placed in operation. A Columbia River cable crossing for connection to the Portland area system was completed in 1932 by Northwestern Electric Company. In 1958, an overhead transmission line river crossing was completed to replace the cable.

The Ariel-Northern Transmission Line (now the Merwin-Kalama Line) was completed in 1935 by Inland Power and Light Company and was initially operating at 66 kilovolts. In 1952, the line was reconductored and converted to 115-kilovolt operation.

Neither transmission line was included in the original project. It is the opinion of Pacific Power & Light Company that both lines are "primary lines" under present Commission criteria and, accordingly, are included as such in the application for relicense.

Project Description

The Merwin hydroelectric project consists of a powerhouse containing three turbine-generator complexes and a concrete dam forming a reservoir of 4,040 surface acres (1,635 ha) at full pool extending about 14.5 miles (23.3 km) upstream from the dam. An exterior view of the dam and powerhouse is shown on figure 11, and a summary of pertinent data is presented in table 2.

The dam consists of a concrete-arch section with a crest length of 728 feet (222 m) and maximum height of 313 feet (95 m) at elevation 240 feet (73 m), a gravity non-overflow thrust-block section with a crest length of 75 feet (23 m), a gravity ogee crest spillway section with a crest length of 206 feet (63 m), and a gravity non-overflow section with a crest length of 208.7 feet (63.6 m). The spillway has four Tainter gates, each 39 feet (11.9 m) wide by 30 feet (9.1 m) high, and one Tainter gate 10 feet (3.0 m) wide by 30 feet (9.1 m) high. Maximum discharge capacity of the concrete gravity-type overflow spillway with the energy head at the dam crest (elevation 240 feet (73.1 m) m.s.l.) would be 132,600 cubic feet per second (3,755 m^3/s). The centerline of intake for each of the three power units is located at elevation 60 feet (18.3 m), and each penstock is 15.5 feet (4.7 m) in inner diameter and 150 feet (45.7 m) in length. A fourth penstock stub of the same diameter is available for future expansion. Three 17-foot (5.2-m) diameter butterfly valves are located in the operating penstocks at the downstream face of the dam.

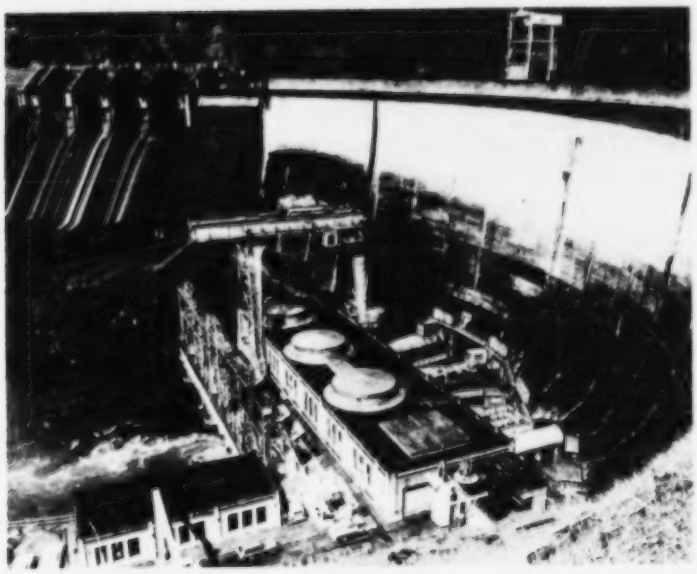


Figure 11. Merwin Dam and powerhouse.

The reservoir has a gross storage capacity of 422,800 acre-feet (521,500,000m) and a usable storage capacity of 264,000 acre-feet (325,600,000m^3) between normal maximum water surface elevation 239.6 feet (73.0 m) and minimum water surface elevation 165.0 feet (50.3 m) m.s.l., 112.8 feet (34.4 m) above intake inverts. Normal minimum pool is at elevation 210 feet (64.0 m) m.s.l., above which about 112,100 acre-feet (138,300,000 m^3) of storage capacity is available. A sectional view of the powerhouse project dam and powerhouse is shown on figure 12. Maximum reservoir width is about 1.5 miles (2.4 km). Several small tributaries flow into the reservoir, the two principal ones being Speelyai and Canyon Creeks.

The powerhouse is a concrete semi-outdoor-type building, containing three units and provisions for expansion to four units. It is located immediately downstream from the dam. Its three Francis turbines are each rated at 55,000 horsepower at 170 feet (51.8 m) of head and 120 revolutions per minute. The three semi-outdoor umbrella-type generators are each 56,250 kilovolt-amperes (45,000 kilowatts at 0.8 power factor). There is one station service unit with a capacity of 1,250 kilovolt-amperes (1,000 kilowatts at 0.8 power factor), bringing the total project nameplate capacity to 136,000 kilowatts. A summary of pertinent turbine and generator data is presented in table 3.

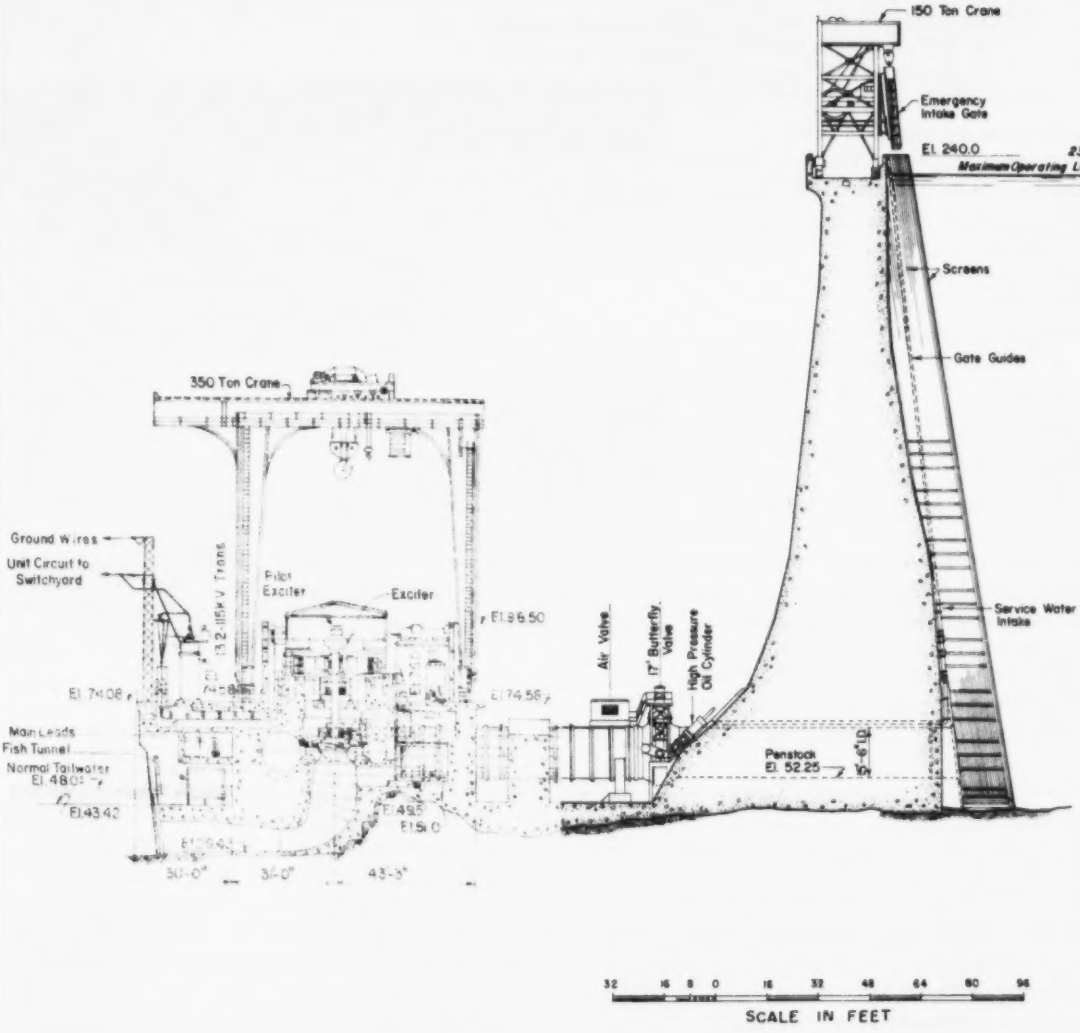
The plant's total (including station service) average annual generation approximates 539,500,000 kilowatt-hours; therefore, the average capacity factor, with average energy related to 143 megawatts of dependable capacity, is 43 percent. An interior view of the project powerhouse is shown on figure 13. The equipment is serviced by a 350-ton (317.5-t) outdoor gantry crane with a 25-ton (22.7-t) auxiliary hoist. An integral fish trap and removal device is located under the powerhouse platform. Nine single-phase 13.2-115-kilovolt transformers are located on the upper powerhouse deck and are connected to the switchyard through three 115-kilovolt circuits. The three generator circuits terminate at an adjacent switchyard where a transmission line, which is part of the Yale project (Project No. 2071), also terminates. Two transmission lines, which are not licensed, extend from the switchyard to the load centers, as follows: (1) a 115-kilovolt line extending northwesterly about 15.9 miles (25.6 km) to the Bonneville Power Administration (BPA) transmission line at Cardwell Substation near Kalama, Washington, where it connects with the BPA system; and (2) a 115-kilovolt line extending south to and including the take-off structure at the St. John's Switching Station near Portland, Oregon, where it connects with Pacific's Portland system and with the BPA system.

Table 2

Pertinent Data
Merwin Project

Plant Name		Merwin
Owner		Pacific Power and Light Company
Project Number		935
Year of Initial Operation		1931
Date License Expires		December 11, 1979
River		Lewis
River Mile		19.6
Drainage Area, sq mi (km^2)		731(1,893)
Flows	cfs	m^3/s
Average Annual 1/	4,875	138
Maximum recorded 1/	129,000 2/	3,650 2/
Spillway capacity (pool elev. 240 ft)	132,600	3,755
Hydraulic capacity of plant	10,817	306
Elevations above msl	feet	meters
Top of dam parapet, and top of gates	240.0	73.2
Normal maximum pool	239.6	73.0
Normal minimum pool	210.0	64.0
Minimum pool	165.0	50.3
Crest of Spillway	205.0	62.5
Tailwater with average annual flow	50.2	15.3
Heads	feet	meters
Gross static	191.6	58.4
Net effective (approximate)	180.9	55.1
Reservoir Area	acres	hectares
Normal maximum pool	4,040	1,635
Reservoir Volume	acre-feet	m^3
Normal maximum pool	422,800	521,500,000
Normal minimum pool	310,700	383,200,000
(Normal Active Power Storage)	(112,100)	(138,300,000)
Powerplant		
Installed capacity, MW		136 3/
Average annual generation, MWh		539,500

1/ At Ariel 0.5 mile downstream of powerplant, 54 years of record, water years 1924-77.
2/ December 22, 1933.
3/ Includes station service unit of 1 MW.



MERWIN PROJECT

Project No. 935

CROSS SECTION OF ARCH DAM AND POWERHOUSE

LEWIS RIVER BASIN

FERC-Water Resources Appraisal for Hydroelectric Licensing — Figure 12

Table 3

Generating Plant Data
Merwin Project

	Unit No.			
	1	2	3	Station Service
Turbines				
Rated Head, ft	170	170	170	150
Rated Head, m	51.8	51.8	51.8	45.7
Operating Speed, rpm	120	120	120	720
Capacity at rated head, hp	55,000	55,000	55,000	1,050
Capacity Equivalent, kW	41,030	41,030	41,030	783.3
Type	-- All vertical shaft Francis --			
Year Installed	1931	1949	1958	1931
Generators				
Nameplate Capacity, kVa	56,300	56,300	56,300	1,300
Nameplate Capacity, kW	45,000	45,000	45,000	1,000
Power Factor, %	80	80	80	80
Voltage, V	13,800	13,800	13,800	2,400
Phase and Frequency	3-60	3-60	3-60	3-60
Year Installed	1931	1949	1958	1931

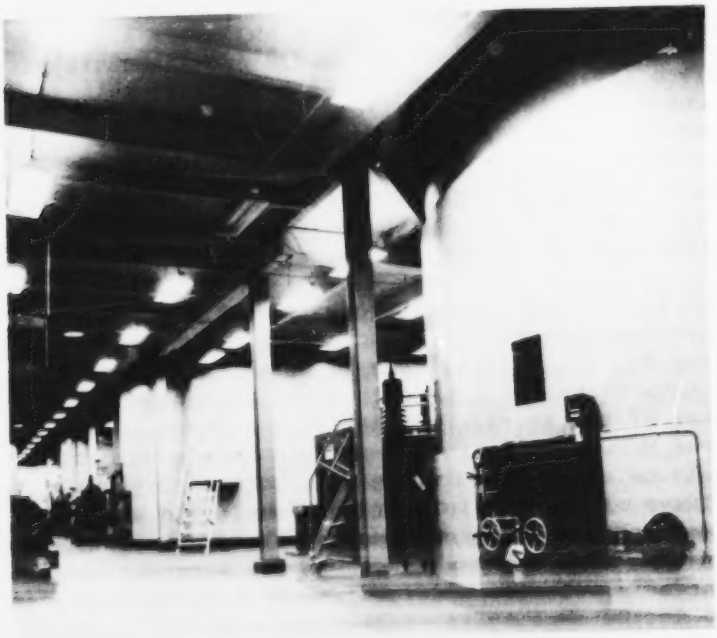


Figure 18. Merwin basement, interior view.

Pacific operates and maintains two recreational facilities on Lake Merwin. The Merwin picnic ground and swimming area located near the dam offers tables and electric stoves, a large playing field, a parking area, a protected swimming area with swim float and large restrooms. Farther east along the north shore is Speelyai Bay Park, which has a picnic area, a cooking shelter, a boat launching ramp, a parking area, a small protected swimming area, and one large restroom.

Condition of Project

The San Francisco Regional Office staff inspects the project facilities annually. Based on those

good operating condition and has been well maintained. The concrete structures are generally in good condition with only minor surface spalling and weathering. No uncorrected conditions have been observed which could adversely affect the structural integrity or safety of the project. According to an independent consultant's inspection report, filed in compliance with the Commission's Order No. 315, there are no significant deficiencies in the condition of the project structures, the quality and adequacy of maintenance, or the methods of operation, which might endanger public safety.

Present Operation

The Merwin hydroelectric project is operated in conjunction with the two upstream reservoir projects, Yale and Swift. Merwin serves as a flow reregulating project. Inflow to the Merwin Reservoir consists of the release from the Yale project, plus runoff from the intervening drainage area of 135 square miles (350 km^2). The outflow from Merwin is a function of minimum flow requirements and the available water from local inflow and upstream releases.

The minimum outflow is usually in excess of 800 cubic feet per second (23 m^3/s), although the license provides for a minimum release of 760 cubic feet per second (21.5 m^3/s), or natural inflow, whichever is the lesser amount. The daily fluctuation in surface elevation at Merwin Reservoir seldom exceeds 10 feet (3 m). During normal operation, the reservoir remains full in June, July, and August. The average water surface level is lowered starting in October to accommodate the expected high runoff. About 23 feet (7 m) of the reservoir is utilized for pondage from November through April. The reservoir elevation is raised during May and usually returns to full elevation by late June or early July. The existing three-reservoir system is operated to achieve optimum benefits for power with substantial flood control benefits resulting.

Maximum total turbine capacity for three units at the Merwin project is about 11,000 cubic feet per second (311 m^3/s), and turbine capacity for most efficient operation is about 2,700 cubic feet per second (76 m^3/s) per unit. Spillway capacity is 100,000 cubic feet per second (2,832 m^3/s) through five spillway bays with the reservoir at elevation 235 feet (71.6 m). Spilling is generally confined to the winter months and occasionally in the spring. The project is operated in coordination with the Northwest Power Pool and under the Pacific Northwest Coordination Agreement.

The Merwin project is not subject to known geologic hazards except the active volcanism of the Cascades. The predominant hazard associated with volcanism is considered to be a mudflow from Mt. St. Helens, some 20 miles from the upper end of Merwin Reservoir. Lava flows and ash falls would probably pose less significant hazards. Because of the storage availability and spillway capacities of the Swift, Yale, and Merwin projects, it is felt that a volcanic induced mudflow and flooding would be attenuated in the reservoirs and the waters discharged over the spillways without failure of the dams. The settling of mudflow debris would reduce downstream situation damage. The presence of the three projects can, therefore, be considered an asset to the retardation of downstream damage in the event of a volcanic mudflow from Mt. St. Helens. During the 1980 eruptions of Mt. St. Helens, these projects experienced very little interference of operations. However, the long-term impacts, if any, on the basin's hydrologic characteristics are not yet fully known.

CHAPTER VI

NEEDS FOR FURTHER DEVELOPMENT OF WATER AND RELATED LAND RESOURCES

General

The major water resource management problems in the Lewis River basin are related to water quality, groundwater availability, and municipal supply. Lesser needs include flood control, preservation of instream flow values, and water-related recreational facilities.

Electric Power Needs

Electric power needs in the Lewis River basin are small when compared to the power produced by hydroelectric projects in the basin. The estimated total 1978 Clark County PUD No. 1 and Cowlitz County PUD No. 1 peak load in the basin was 68.7 megawatts and annual energy was 342,500 megawatt-hours. This represented only a small part of the total load served by the two Public Utilty Districts. Most of the output from the Lewis River plants is exported to serve adjoining Pacific Power & Light Company service areas and the Company's interconnected system.

Estimated future requirements for the two Public Utility Districts and the Pacific Power & Light Company are shown in table 4. The estimates by the Public Utility District No. 1 of Clark County reflect average annual growth rates for 10 years of 6.2 percent and 3.3 percent for energy requirements and peak demand, respectively. The Public Utility District No. 1 of Cowlitz County's estimated annual growth rates for 10 years are 6.8 percent for energy requirements and 6.5 percent for peak demand. The estimated annual growth rates for Pacific Power & Light Company are 5.7 percent for energy requirements and 5.6 percent for peak demand.

Consideration of the power requirements of the two Public Utility Districts and the Pacific Power & Light Company necessitates an examination of the loads and resources of the entire Northwest Power Pool. An annual West Group forecast is prepared by the Loads and Resources Subcommittee of the Pacific Northwest Utilities Conference Committee (PNUCC). Its objective is to show the estimated peak and energy loads and the peak and energy capabilities of existing and planned resources to meet these requirements. The estimated annual rate of load growth for the area for the 10-year period, 1978-79 to 1988-89, is approximately 4.4 percent for peak demand and 4.2 percent for energy requirements. Even though the load estimate was reduced by the PNUCC from that presented in last year's forecast, under adverse water conditions energy deficiencies are projected in every year through 1988-89 under the present schedule of resource additions.

Flood Control Needs

Flooding in the Lewis River basin has historically been relatively insignificant. No damaging floods are known to have occurred upstream from Merwin Dam -- owing to sparce development and reservoir regulation, nor is flooding significant

Table 4

Estimated Future Power Requirements

	Clark County PUD No. 1		Cowlitz County PUD No. 1		Pacific Power & Light Co. 2/	
	Energy for Load (MWh)	Peak Demand (MW)	Energy for Load (MWh)	Peak Demand (MW)	Energy for Load (MWh)	Peak Demand 3/ (MW)
1978 1/	2,443,099	730	3,108,654	498		
1979	2,907,806	679	3,878,490	638	21,619,680	4,433
1980	3,236,484	714	4,198,960	649	22,899,888	4,679
1981	3,384,120	749	4,491,690	710	24,125,040	4,940
1982	3,534,133	785	4,914,060	798	25,482,840	5,213
1983	3,686,181	823	5,267,595	826	26,910,720	5,506
1984	3,840,227	859	5,472,835	851	28,512,864	5,813
1985	3,996,421	897	5,632,070	878	30,055,560	6,139
1986	4,153,651	935	5,774,750	895	31,755,000	6,484
1987	4,313,242	974	5,883,500	916	33,568,320	6,848
1988	4,474,757	1,013	5,993,025	937	35,575,200	7,234
1989	4,637,832	1,052	6,106,300	958	37,492,800	7,641
1990	4,802,524	1,092	6,220,180	978		

Source of data: Utilities.
1/ 1978 actual; other estimated.
2/ For entire Company (Oregon, Washington, California, Wyoming, Montana, Idaho) -- separate systems interconnected by transmission systems of BPA and other utilities.
3/ Net system peak; including borderline deliveries.

near the river's confluence with the Columbia River, due to Corps of Engineers' dikes and Columbia River reservoir regulation. Some flooding has occurred, however, along the Lewis River in the Woodland area and along the East Fork Lewis River. In addition, local runoff, compounded by high water table and poor drainage conditions, has caused isolated flooding in Woodland.

The existing Lewis River power reservoir system (Project Nos. 935, 2071, and 2111) is operated to achieve optimum power output. The reservoirs are drawn down in the fall in anticipation of high runoff during the subsequent spring. Such practice provides maximum usefulness of water for power production while, at the same time, reducing downstream river stages during the normal flood season. For purposes of flood insurance studies, however, the Federal Emergency Management Agency (FEMA) guidelines do not allow consideration of the flood control benefits from this storage, since no formal flood control operating plan exists.

The Deputy Director of Civil Works, U.S. Army Corps of Engineers, in a letter, dated June 1, 1977, to the Chairman, Federal Power Commission, stated that consideration of flood control capability beyond that which is currently provided in the three reservoirs on the Lewis River is not warranted at this time, because the resulting power losses would far exceed the potential benefits from the added flood control.

In summary, while it does not appear that significant new [illegible] for flood control would be economically justified in the basin, it is believed

that future flood damages can be minimized through non-structural study and regulatory measures and possibly by modified reservoir operations. There is first a need to determine precisely the undeveloped lands with floodwater hazard problems. Such an effort would be essential to determine which areas would be zoned to prevent more intensive land uses gaining access. Flood plain information and flood hazard studies are needed for streams where urban build-up is presently heavy or anticipated.

Water Supply Needs

Adequate water resources exist in the Lewis River basin to provide all foreseeable basin water requirements through the year 2020. However, storage and transportation of water to those areas, that will not have an adequate supply during periods of heavy use, will have to be provided. Future water requirements will be determined primarily by the rate of growth of population and agriculture and by how efficiently water is to be used. Projections indicate that total basin water use will increase by about 88 percent by the year 2020.

There is interest in exporting water from the basin. An engineering report by R.W. Beck and Associates, Consulting Engineers, states that the Lewis River appears to be the only surface water source that is of sufficient magnitude to meet the long-term requirements of Clark County. The river is favorably located to serve the major part of the County, particularly the City of Vancouver, Washington. Extensive treatment or watershed control would not be required to ensure the purity of the water. Clark County Public Utility District No. 1 has a water right to 300 cubic feet per second (8.5 m^3/s) from the Lewis River. This right is not used at present, because other water supplies available to the county are adequate for present needs. When it becomes necessary in the future to develop this water, it will be used throughout Clark County for municipal and industrial use.

There is a need for a study to determine adequacy of groundwater supply in Clark County. In some areas the level of the water table is dropping rapidly, and the deeper wells have iron content problems. Whether Clark County can continue to grow and depend upon groundwater as a source of additional supply is not known.

Irrigation and Drainage Needs

Accelerated development of the potentially irrigable lands is required if the basin is to achieve maximum potential in food and fiber production. Potential sources of water for these lands are the further development of existing facilities utilizing both ground and surface sources and the development of additional aquifers and surface storage. Water needs for irrigation can be partially met by improved water management and increased efficiency of irrigation systems.

Additional drainage is required on the cropland for more productive use of land. These include cleaning drainage ditches; improving and adding additional outlets, pumping plants, and tile drains; and intercepting seepage from higher grounds.

Steam-Electric Cooling Water Requirements

There are no steam-electric generating plants in the basin. No plans are known for the construction of a steam-electric generating plant.

Pollution Abatement and Public Health Needs

Anticipated future growth will require additional quantities of high quality water to satisfy domestic water demands.

As previously mentioned, water quality is generally good in the basin. The potential for stream siltation as the result of timber harvest, road location, and similar developments represents the most serious threat to water quality. Of these, road location is the most significant.

A major water quality problem exists in rural-farm and rural-nonfarm areas due to contamination of groundwater supplies from septic tanks. Similarly, along the East Fork of the Lewis River some septic tank wastes go directly from homes into the river. To maintain overall water quality standards, septic tank locations and sanitary land fill sites must be carefully considered.

Recreation Needs

Recreation use is expected to increase, and additional facilities will be needed to satisfy recreation demands. Several agencies have projected future plans which are subject to availability of funds and the recreational needs of the public.

The U.S. Forest Service has proposed four expanded or new developments in the basin. Present plans for the Ape Cave Geological Site call for a visitor center and an expanded trail system to include other geologic phenomena of the area. Two proposed new developments would be for campgrounds. One site contains 90 acres (36 ha) near the confluence of the Lewis River and Pass Creek. The other site would occupy 60 acres (24 ha) near Rush Creek. If fully developed, these 2 sites would contain 500 campsites and 70 picnic sites. Long-range Forest Service plans include the addition of approximately 20 miles (32 km) of trail in the upper part of the basin.

Pacific Power & Light Company has conducted several studies of future recreation development on its reservoirs. Construction is not scheduled to begin until 1983. The company also plans to enhance the scenic view of Lake Merwin from Washington Highway 503 through selective clearing of trees and brush.

Clark County is rehabilitating the Lewisville Park on the Eask Fork Lewis River. The project began in 1978 and will continue for several years.

Fish and Wildlife Needs

The anticipated future population growth in southwestern Washington will severely strain the fish and wildlife resources of the basin. Present management of these resources has concentrated on the basin fishery with emphasis on anadromous species. Wild anadromous and resident fish populations are supplemented by the planting of hatchery fish. This practice is expected to increase. Intensive management of the basin's lakes and reservoirs will be needed to meet projected

demands. High elevation lakes which presently receive little management, will provide an important source to meet the future recreation fishing demands.

Wildlife populations can be increased to meet hunting pressures by improved habitat management. Research currently being carried on by the Washington Department of Game will identify critical habitat for wildlife species.

Continued research is needed to manage the basin's fish and wildlife resources to satisfy future needs.

CHAPTER VII

POSSIBLE FUTURE DEVELOPMENT AND UTILIZATION OF WATER RESOURCES

General

The Commission's license for Pacific Power & Light Company's Merwin Development, Project No. 935, expired on December 11, 1979, and a new license is required to continue operation and maintenance of the project. The Commission, under the Federal Power Act, must decide whether to issue a new license to the original licensee or to a new licensee or to recommend takeover by the Federal Government. This chapter discusses future development and utilization of the water resources in the Lewis River basin to provide information that will aid the Commission and its staff in making decisions relating to these matters.

This report does not formulate a plan for basin development or a program for implementing such a plan; it discusses potential water resource developments which could provide opportunity for further economic development and which could assist in meeting future needs in the basin. The Commission staff has reviewed available plans of Federal, State, and local agencies, and the Pacific Power & Light Company, and in addition, has made its own studies for potential future developments. Also considered is how the Merwin project could be modified to provide additional power or meet the needs of other water resource problems. If any additional plans have been made by others, the staff would identify their relationship to the Merwin project and determine if and how such plans would mesh with the Merwin project to optimize the water resources benefits for the basin. It is expected that the principal purpose of all potential developments would be hydroelectric power production. Potential secondary benefits would consist of flood control, municipal and industrial water supply, water-oriented recreation, and fish and wildlife enhancement. Potential projects are listed in table 5 and are located on the Development Map (figure 4) in chapter IV.

The project plans presented herein are of a reconnaissance level and denote the type, complexity, and general economic feasibility of individual projects considered. Detailed planning would be required to determine a project's final features, scope, and economic justification.

Basis for Analyses

In evaluating the Merwin project and the potential projects in the basin, annual costs associated with each project were compared with the estimated annual power benefits. Annual costs used included operation and maintenance (O&M) expenses, administrative and general (A&G) expenses, and fixed charges. O&M and A&G expenses for the Merwin project were based on historic trends and in all other cases were estimated in accordance with procedures of the August 1979 FERC publication entitled, Hydroelectric Power Evaluation. For assumed Federal financing, the fixed charge rate of 7.87 percent included interest and amortization using an interest rate of 6-7/8 percent, and insurance (in lieu of). For private financing, the fixed charge rate of 15.02 percent included the cost of money at 10.5 percent, amortization, insurance, and State and local

Table 5

Potential Hydroelectric Developments
Lewis River Basin

Project	Stream	Head (ft)	Head (m)	Installed Capacity (MW)	Average Annual Generation (GWh)
		Conventional			
Charter Oak	East Fork Lewis R.	240	(73)	26.8	117.4
Lucia Falls	East Fork Lewis R.	360	(110)	32.0	140.2
Horseshoe Falls	East Fork Lewis R.	440	(134)	18.7	82.3
Johnson Creek	Lewis River	18	(5.5)	14.3	62.2
Merwin (expansion)	Lewis River	192	(59)	70.0	29.8
Tumtum Mountain	Canyon Creek	561	(171)	36.2	158.6
Yale (expansion)	Lewis River	250	(76)	108.0	199.7
Muddy	Lewis River	300	(91)	110.0	417.9
Clear Creek	Clear Creek	750	(229)	5.8	38.5
Clearwater Creek	Muddy River	300	(91)	6.5	49.1
Paradise Falls	Clearwater Creek	760	(232)	17.0	66.6
Meadows Lower Drop	Lewis River	1,050	(320)	55.0 1/	76.2
Meadows Upper Drop	Rush Creek	810	(247)	30.0	184.0 2/
Cascade Gorge	Lewis River	245	(75)	22.0	99.0
Quartz Creek	Lewis River	415	(126)	12.7	92.0
Steamboat Creek	Lewis River	550	(168)	9.5	73.6
Twin Falls	Lewis River	500	(152)	11.4	49.9
			Totals	585.9	1,937.0
		Pumped Storage			
Yale (expansion)	Lewis River	250	(76)	500	consumptive
Merrill Lake	Lewis River	1,080	(329)	500	consumptive
Swift	Lewis River	510	(155)	1,000	consumptive
Grass Lake	Lewis River	910	(277)	6,000	consumptive
Lone Butte	Lewis River	2,000	(610)	10,000	consumptive
Skookum Meadow	Lewis River	2,000	(610)	10,000	consumptive
Swampy Meadows	Lewis River	1,460	(445)	10,000	consumptive

1/ *Includes 30 MW that would be developed as part of Meadows Upper Drop project.*
2/ *A portion of this average annual generation would be developed at Meadows Lower Drop project.*

taxes. And for public non-Federal financing, the fixed charge rate of 8.93 percent included the cost of money at 6.5 percent, amortization, insurance, and State and local taxes.

Annual power benefits of all projects considered were based on the cost to deliver similar total system power using alternative steam-electric generation. Financing of alternative generation was assumed to be 25 percent private and 75 percent public. All dollar values shown were based on the extrapolation of prices to the December 1979 level.

Analysis of the Merwin Project

Continued Operation of Existing Facilities

Applications have been filed with the Commission by Pacific Power & Light Company and the Clark-Cowlitz Joint Operating Agency for a new license to operate and maintain the Merwin project. These applications have been consolidated for the purpose of future proceedings by the Commission.

The Merwin project appears to be well-maintained based on inspections performed annually by the Commission staff and also based on periodic inspections performed by an independent consulting engineering firm. Repairs and replacements have been made as needed, and the project is physically capable of continued efficient operation for many years as a basic element of the comprehensive development of the basin.

The net investment of the Merwin development of $9,540,257 is considered to be the project capital investment minus the estimated and reported depreciation and amortization as of December 11, 1979, the license expiration date. Power values used in the determination of project benefits should be revised when more precise values become available. However, as shown in table 6, the continued operation of the Merwin project is decidedly favorable for all methods of financing, and revisions to the power values are not expected to alter this conclusion. Severance damages, if any, which would be required for public takeover of the project have not been determined by the Commission and were not included in this analysis.

Table 6

Economic Analysis of
Project No. 935

No. and size of units, MW	3 @ 45
Nameplate capacity, MW	135
Avg. annual generation, GWh	534.5
Capacity factor, %	42.7
Dependable capacity, MW	143
Power values	
$/kW-yr.	67.23
mills/kWh	26.6
Annual benefits, $1,000,000	24
Net investment, $1,000,000	9.5
Annual cost, $1,000,000	
With private financing	1.9
With public non-Federal financing	1.4
With Federal financing	1.3
Benefit-to-cost ratio	
With private financing	12:1
With public non-Federal financing	17:1
With Federal financing	19:1

Note: Analysis excludes station service unit.

Potential Utilization of the Merwin Project in the Comprehensive Plan

The Lewis River basin was included in the 1972 report, "Columbia-North Pacific Region Comprehensive Framework Study of Water and Related Lands" (Framework Study). This study was prepared under the ageis of the Pacific Northwest River Basins Commission and provides a guide for the best management use, development, and conservation of the region's water and related land resources. Discussion of the needs of the Lewis River basin was included in the Framework Study's discussion of the Lower Columbia subarea (Subregion 8). It was also included in the Lower Columbia subarea and the Cowlitz River basin and some smaller basins. The following subsections consider the potential contribution the Merwin project could make to the applicable basin needs.

Flood Control: Pacific Power & Light Company states in exhibit H of their application for relicense that "[their] normal operation during the October through April high run-off season provides at least 70,000 acre-feet of storage space to control high discharges of the Lewis River. Power operations (average river flows and loads) will normally increase this space to 100,000 acre-feet by November 15 and retain this space, or more, through March of each year. Only in case of high run-off or reduced load requirements will the reservoirs be refilled to the 70,000 acre-feet storage level during this period."

This flood control regulation is not considered to be effective by the Federal Emergency Management Agency (FEMA) since no formal flood control operating plan exists. Consequently, Flood Insurance Studies of the Lewis River basin below Merwin Dam determined a 100-year flood plain and a floodway which encompass more land than if the upstream storage had been considered effective.

Formal requirement, by license article, providing the three Lewis River reservoirs the flood control storage which is already provided, may result in improved insurance coverage or lower premiums for downstream property owners without adversely impacting Pacific Power & Light. The required flood control plan would typically be under the direction of the District Engineer, Corps of Engineers. It would, however, adversely impact the collective power output of the three projects if all or part of the proposed flood control storage were to be required in any one of the three reservoirs at all times.

The Deputy Director of Civil Works, U.S. Army Corps of Engineers, in a letter dated June 1, 1977, to the Chairman, Federal Power Commission, stated that consideration of additional flood control capability beyond that which is currently provided for in the three Lewis River reservoirs is not warranted at this time since the resulting power losses would far exceed the potential benefits from the added flood control.

Water Supply: Clark County Public Utility District has a water right to 300 cubic feet per second from the Lewis River. This is approximately 6 percent of the average annual discharge of the river at Ariel, based on the 1931 to 1974 period of records. This right is not used at present because other water supplies available to the county are adequate for present needs. The County is currently preparing a financial feasibility study on the conveyance system for the Lewis River water supply. A tentative non-feasibility finding for the project is suggested because of present high interest costs. A past study by Clark County Public Utility District indicated that diversion of 300 cubic feet per second at Swift Reservoir would decrease the river's annual energy production

by about 129.5 million kilowatt-hours (about 8.9%) to 1,448.6 million kilowatt-hours (based on 30-year -- 1928 to 1958 -- water records). Diversion at Yale would decrease energy production by about 69.6 million kilowatt-hours (about 4.6%) to 1,508.5 million kilowatt-hours.

Power Supply: At the time of construction, provisions were made for the expansion of the Merwin project. As shown on figure 10, the penstock stub and foundation for the final expansion (fourth intake) are located adjacent to the existing units and toward the right bank.

This fourth intake facility, originally designed to supply one 45-megawatt unit, has the hydraulic capacity to support 70 megawatts of additional installed capacity. The intake would bifurcate to two units, one 50 megawatts and one 20 megawatts. These additions could provide about 65 megawatts of dependable capacity and 30,000 megawatt-hours of average annual energy. The 20-megawatt unit, with a hydraulic capacity of about 1,500 cubic feet per second (42 m^3/s), would provide more efficient operations during low discharge conditions.

Minimal benefits would result at the present time from the expansion of facilities at Merwin Dam, since relatively little additional energy would result. When additional system capacity is required, expansion of the Merwin project should be reconsidered. At no time in the future are expansions beyond that discussed above expected to be practical, since streamflow reregulation is not provided downstream from the dam.

Takeover by the Federal Government

A takeover of the operation of Merwin project by the Federal Government for other water resource purposes would deprive the licensee of an economical source of hydroelectric energy for its customers which would have to be replaced by other alternatives. The alternative energy source would probably result in higher costs to consumers and may introduce a negative effect on local environmental considerations such as air and water pollution caused by fossil-fuel generation. There are no known irrigation uses or future needs that would require modification in design or operation of the project. Operation of the project for flood control is coordinated with the licensee's other two projects on the Lewis River. Acquisition of domestic water supplies from the project reservoir by metropolitan areas in the vicinity of the project could be accomplished without regard to the ownership of the project. It would not be expected that there would be any significant change in the operation of the project for either power or nonpower purposes in case of ownership and operation by the Federal Government. If the Federal Government should take over the Merwin project, it would be necessary for the Federal Government to arrange for coordination of that project on a daily and weekly basis with Pacific Power & Light Company, the continuing licensee for the Yale and Swift storage projects upstream. Split ownership, as a result of Merwin takeover, could reduce the efficiency of water management.

Staff estimated the net investment in the Merwin project as of December 11, 1979, to be $9,540,257. No amounts of amortization reserve under section 10(d) of the Federal Power Act nor severance damages were considered in this estimate. The licensee, in its application for a new license, estimated that the minimum severance damages to be incurred would be $434,300,000 if the hydroelectric

plant were to be separated from its system. Negotiated or adjudicated severance damages would be payable by the Federal Government in the event of takeover. Under terms of the present license, the licensee pays about $114 annually to the Federal Government for use of public lands.

Conventional Hydroelectric Potential

Muddy Project

As shown on figure 4, the Muddy project is located on the Lewis River at about river mile 61 and about 20 miles (32 km) east of Cougar, Washington. The dam itself would be located near Eagle Cliff at the upstream end of Swift reservoir. The project would include an earthfill dam 285 feet (86.9 m) high and 1,800 feet (549 m) long, having a total volume of 7,310,000 cubic yards (5,590,000 m^3). Muddy Dam would create a reservoir having a normal maximum pool elevation of 1,300 feet (396 m) and a gross storage capacity of 277,000 acre-feet (342,000,000 m^3). A 1,500-foot (457-m) long, 18-foot (5.5-m) diameter lined tunnel would connect the reservoir to a powerhouse with an installed capacity of 87 megawatts capable of generating 381,000 megawatt-hours of average annual energy on either a run-of-river or regulated basis. The average flow through the powerplant would be about 2,024 cubic feet per second (57.3 m^3/s), and the average gross head would be 300 feet (91 m).

Diversion of Pine Creek into the Muddy reservoir could increase the project's installed capacity to 110 megawatts and its average annual generation to 417,900 megawatt-hours.

Anadromous fish passage up the Lewis River to the project site is prevented by the downstream reservoirs of Pacific Power & Light Company. The reservoir would inundate land within Gifford Pinchot National Forest, but no major relocation of roads or population would be required.

An FPC license application (Project No. 2112) was filed after the completion of a feasiblity study in November 1956 by Pacific Power & Light Company with Cowlitz County PUD No. 1 as a participant. A general lack of interest in development of the project, however, led to abandoning the application in April 1975. A July 1977 Site Selection Survey prepared by R.W. Beck and Associates for the City of Seattle ranked the Muddy site second among 134 potential sites in the State of Washington. At this time, no further interest in the project has been expressed.

Staff estimates the benefit-to-cost ratios for the Muddy project to be 0.7, 1.1, and 1.3 for private, public non-Federal, and Federal financing, respectively.

Meadows Project

Features of the Meadows development are shown on figure 4.

Initially, the Meadows hydroelectric project would include a diversion of Big Creek water by canal into the upper part of the Meadow Creek (a tributary of Rush Creek) drainage area; a diversion of Curly Creek water via conduit and canal into Rush Creek; and a diversion of the natural flow of Rush and Meadow Creeks, together with the diverted flows of Big and Curly Creeks, into a conduit and canal leading to the Lower Drop forebay, from which a steel penstock

would carry the water to a powerplant located on the proposed Muddy reservoir. This initial installation is commonly referred to as the Meadows Lower Drop project. The plant would operate essentially on the unregulated runoff of the contributing drainage area, with approximately 180 acre-feet (222,000 m^3) of pondage available in the forebay for daily and weekly use, depending on the actual inflow. There would be no effect on the generation of existing and proposed Lewis River projects below this plant.

An ultimate development would add the Meadows Upper Drop project to the initial works as follows: an earth and rockfill dam would be constructed on Big Creek and an earthfill dam would be constructed at Skookum Meadow. These two dams would provide impoundment in the Skookum reservoir. Waters from the Skookum reservoir would discharge directly (without passing through power turbines) into the Meadow pool. Upon construction of Skookum reservoir, the initial Big Creek diversion works would be flooded out. A dam would be constructed on Meadow Creek approximately 1-1/2 miles (2.4 km) above its confluence with Rush Creek. The Meadow pool would extend (via a canal) to the Skookum Saddle Dam. A pumping plant would be located at the Skookum Saddle Dam to pump the Meadow Creek surplus runoff into the Skookum reservoir. Water would be taken from Meadow Creek pool either by canal or by tunnel and conduits to a forebay. From this forebay, a penstock would carry these waters to the powerplant to be located on Rush Creek diversion dam pool (which would be part of initial construction). This powerplant would have an installed capacity of approximately 30,000 kilowatts. An additional conduit and canal would be built from Rush Creek to the Lower Drop forebay, and an additional penstock would be built leading to a second unit in the powerplant on Muddy reservoir. The probable size of this second unit would be about 30,000 kilowatts. The ultimate development would provide storage for 60,000 to 75,000 acre-feet (74,000,000 to 93,000,000 m^2) for use at site and at downstream plants on the Lewis River and for an approximate installation of 85,000 kilowatts.

The initial works and the ultimate development would be completely compatible and, further, the initial works would not require expenditure of any large amount of funds to make possible the additions required to complete the ultimate development.

Staff investigations determined the benefit-to-cost ratio for the fully developed Meadows project to be less than 0.8:1 for all methods of finance.

Yale Project

A development plan for the existing Yale project was presented to Pacific Power & Light Company by Ebasco Services Incorporated (Ebasco) in July of 1974. At that time Ebasco recommended the installation of a 480-megawatt plant consisting of two 120-megawatt conventional generating units and two 120-megawatt reversible units in 1978-79 and provisions for an additional two 120-megawatt reversible units in 1984 -- for a total plant capacity of 720 megawatts. Recent Commission staff review of regional power demands, however, found an adequate regional supply of peaking capability will likely exist until some time in the 1990's. The Ebasco proposal, therefore, was found to be not economically feasible. Additional study would be required to determine whether additional capacity at the Yale project and/or increased upstream storage could economically develop the 200 gigawatts of potential energy at the Yale site.

Other Known Sites in the Basin

In addition to the potential projects already discussed, 13 conventional projects have recently been inventoried by the Corps of Engineers as part of the preliminary phases of the National Hydropower Study. The data shown in table 5 for these plants are the result of this preliminary site screening. Future phases of the Corps' investigation will include site surveys and somewhat detailed economic studies. It is expected that these more detailed studies will in many cases alter this preliminary data or eliminate the site from further consideration. In addition, local needs and environmental concerns will impact future decisions on these sites. The National Hydropower Study is scheduled for completion in September 1981.

Pumped Storage Potential

The existence of the large Merwin, Yale, and Swift reservoirs provides the possibility of building pumped storage projects between these reservoirs.

Pacific Power & Light Company conducted a study in 1974 on the feasibility of a 500-megawatt pumped storage project using the Merwin and Yale reservoirs. Water from the Merwin reservoir, just downstream, could be pumped into the Yale Reservoir during off-peak nighttime and weekend hours, to be stored for release during subsequent peak-use periods. Geologic and economic feasiblity studies were completed, but additional units were found to be uneconomical at that time.

An investigative study on the feasiblity of a Swift-Yale pumped storage project was made in October 1974 by Cornell, Howland, Hayes & Merryfield, Consulting Engineers for the Public Utility District No. 1 of Cowlitz County, Washington. The report stated that a pumped storage powerplant of at least 1,000-megawatt capacity, utilizing the existing Swift and Yale reserovirs as the upper and lower pools, appeared to have sufficient merit to warrant further study. Financing would be based upon the sale of tax-exempt revenue bonds by the District. It was noted that the large volumes of water in the Swift and Yale reservoirs would permit sustained peaking operation of the project for much longer periods than is possible for the usual pumped storage plant of comparable capacity. The project operations would be compatible with those of the 500-megawatt Yale-Merwin project investigated by Pacific Power & Light Company. Installation of the Pacific project might justify increasing the Swift-Yale project to as much as 2,000 megawatts.

On June 18, 1968, the Federal Power Commission issued a 2-year preliminary permit (Project No. 2658) to the Public Utility District No. 1 of Cowlitz County, Washington, for a proposed pumped storage project at Merrill Lake. Merrill Lake is located about 2 miles (3.2 km) north of Lewis River near Cougar, Washington. Preliminary plans included installing two 250-megawatt reversible units in an underground powerhouse to develop the 1,100 feet (335 m) of head between Merrill Lake and the existing Yale reservoir. When the permit expired, the PUD elected not to apply for a license due to the lack of an immediate demand for the power and opposition to the environmental impacts of the project.

The North Pacific Division of the U.S. Army Corps of Engineers published an inventory of pumped storage sites of the Pacific Northwest in January 1972

which was updated in January 1976. Four additional projects were listed, all of which use the Lewis River as the lower reservoir. The Grass Lake project would have the capability for a 6,000-megawatt installation with a gross head of 910 feet (277 m). The Lone Butte project could develop 10,000 megawatts with a gross head of 2,000 feet (610 m). The Skookum Meadow project could have a plant capacity of 10,000 megawatts with a gross head of 2,000 feet (610 m). The Swampy Meadows could have a plant capacity of 10,000 megawatts with a gross head of 1,460 feet (445 m). Except for the Grass Lake project, all of the additional projects are located within the Gifford Pinchot National Forest. The identification of these four projects was based on an office survey, and possible conflicts with other existing land and water uses or questionable geological conditions for reservoir construction were not considered.

Studies by various public and private groups disagree on the number of years before pumped storage projects could prove to be a beneficial addition to the Northwest power system. The Power Planning Committee of the Pacific Northwest River Basins Commission has estimated the region's first pumped storage project could be utilized in 1996. Recent trends in load growth and resources allocations, however, suggest that pumped storage projects may not be required until sometime after the year 2000.

Geothermal

Increasing interest is being shown in the use of geothermal energy in the basin for electrical power, space heating, agricultural uses, and other commercial applications. Approximately 57 percent of the basin lies within the Gifford Pinchot National Forest which is an area considered to have the potential to produce geothermal energy, according to the United States Geological Survey. The Geothermal Steam Act of 1970 authorizes the Secretary of the Interior to lease geothermal resources on lands administered by the Departments of the Interior and Agriculture. Lease applications on several sites in the basin are currently under consideration pending the completion of environmental impact statements.

Environmental Considerations

Development of any of the potential hydropower sites in the Lewis River basin would result in changes in existing land use patterns and the alternation of streamflow regimes. Of primary environmental concern are the Muddy and Meadows projects, the largest of the potential projects. Both projects would be located within the boundaries of the Gifford Pinchot National Forest upstream of the existing Swift reservoir (Project No. 2111).

The Muddy hydroelectric project would inundate 3,800 acres (1,538 ha) at maximum pool and create a reservoir approximately 8 miles (12.9 km) long. The project would destroy the existing fishery and including lands within the reservoir area would preclude land from timber management, mineral production, and present recreation uses. Also, the project would destroy the Cedar Flats Research Natural Area. The reservoir would create a slack-water recreation area and support a fishery similar to those found in other reservoirs in the basin.

The Meadows project would utilize the streamflow and available head of Big, Meadow, Curly, and Rush Creeks, tributaries of the Lewis River. This project would divert most of the water from the upper reaches of the Lewis River through

canals and conduits for power production. The water would be released into the Muddy River about 3 miles (4.8 km) upstream of the confluence of the Lewis and Muddy Rivers. The project would have a significant impact on the fish and wildlife resources but a minimal impact on existing land uses.

Expansion or modification of existing hydroelectric facilities would provide an opportunity to increase peak output while minimizing environmental problems. Large fluctuations in tailwater elevations and velocities would occur more frequently with the implementation of peaking type operations. Forebays may also experience an increase in fluctuations.

The operation of pumped storage projects at existing or new sites will require careful study of impacts to water temperatures, fluctuation levels, and land use patterns.

In 1978, the staff of the Gifford Pinchot National Forest prepared an environmental impact statement on geothermal leasing and development within the national forest. All national forest lands within the basin were included in the study. The environmental concerns of geothermal development include air pollution, climatic and weather modification, changes in noise levels, and increased population in a rural area. Geothermal development would require new transmission corridor routes, increased road traffic, degradation of water quality, and increased water consumption.

Conclusions

The Merwin project, for which two applications for a new license are pending, is in good condition and capable of being operated efficiently for a number of years in the future. The continued operation of the existing project appears to be economically justified with private or public financing. Severance damages, if any, which would be required for public takeover of the project have not been determined by the Commission. The installation of fourth and fifth units at the Merwin project does not appear to be justified at the present time, since relatively little energy would result and need for peaking capacity may not materialize until some time in the mid to late 1990's.

Seventeen potential conventional hydropower sites have been identified in the Lewis River basin. The potential annual generation at each of these individual projects is under 420 gigawatt-hours, with 114 gigawatt-hours being the average annual individual site potential. Economic data for most of these sites will become available upon completion of the Corps of Engineers National Hydropower Inventory study. Staff studies indicate the undeveloped site with the greatest known economic feasibility is the Muddy development which has a 1.1 to 1 benefit-to-cost ratio using public non-Federal financing.

Seven sites for the potential development of pumped storage hydroelectric power development were identified. However, because of the existence of and opportunities for conventional hydroelectric power for peaking in the Northwest, pumped storage developments may continue indefinitely to be impractical.

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